

YOGA RESEARCH FOUNDATION: VOLUME THREE

Basic Yoga Research 1989–2007



Yoga Publications Trust, Munger, Bihar, India

Basic Yoga Research 1989–2007

With kind regards, ॐ and prem

Swami Niranjan

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Yoga Publications Trust, Munger, Bihar, India

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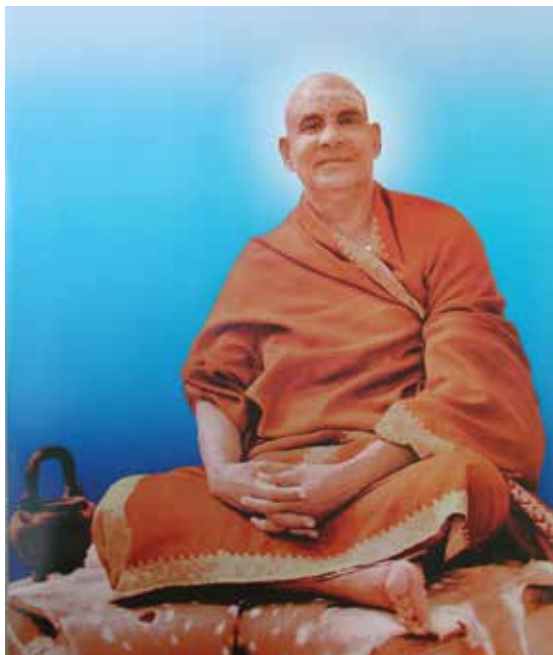
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Dedication

*In humility we offer this dedication to
Swami Sivananda Saraswati, who initiated
Swami Satyananda Saraswati into the secrets of yoga.*

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Preface

Yoga Research Foundation was founded by Swami Satyananda Saraswati in 1984, in Munger. The aim of the institution was to investigate and validate the many aspects of yoga, its techniques, practices and postulates in a scientific manner.

Already in 1977, Sri Swami Satyananda had established the Research Co-ordinating Centre with the same idea and purpose. One of his major contributions in the field of yoga was to introduce yoga to the world of medical and scientific research. Yoga was no longer to be a secret science for sadhus and ascetics, but accessible to one and all. The benefits of yoga are not only a reality experienced by the individual; they can be measured, monitored and analyzed with the most sophisticated scientific equipment available.

Sri Swami Satyananda initiated a worldwide movement of yoga research which carried out projects at hospitals, psychiatric clinics, colleges and universities.

On the occasion of the 14th Foundation Day of Bihar School of Yoga, on 24 January 1977, Swami Satyananda Saraswati addressed a gathering at Sivanandashram in Munger, announcing the creation of the Research Co-ordinating Centre. The following is an excerpt of the address he delivered:

People are coming to Munger from all over the world in order to learn yoga, not only Hindus but people from all religions and walks of life. Today, everyone

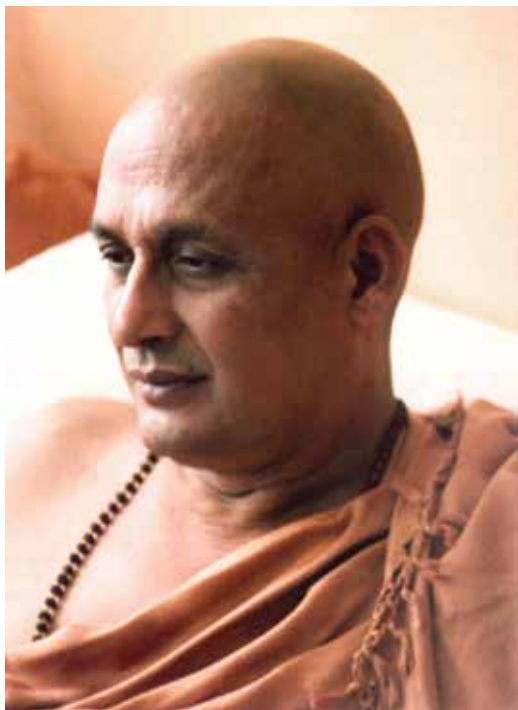
from king to beggar is perplexed, restless, and wants to learn yoga to concentrate the mind, in order to find peace and free their body and mind from disease and tension. This is why our small ashram is transmitting the message of yoga to the whole world.

Many of my sannyasin disciples are doctors, engineers, philosophers and psychologists. Being highly trained, they have a basic understanding of the scientific yogic research going on around the world. Through them whatever research is being done on yoga, East and West, will be brought here, collated and conveyed in a readable form to the people. Our aim is to convey information about the investigations going on in the world. How are alpha waves produced while singing kirtan? How does japa influence blood pressure? What is the effect of relaxation on the mind? What does science have to say about yoga? Over the last five hundred years we have forgotten our yogic culture and spiritual knowledge has nearly disappeared. Today, however, there is a great yogic renaissance going on around the world and spiritual knowledge is again manifesting.

Finally, to all yoga lovers I express the wish that they may share their knowledge and experience with us in the form of assistance and cooperation, so that we can impart this knowledge to the maximum number of people through our new research coordinating centre.

Yoga Research Foundation continues to this day to uphold the vision of Sri Swami Satyananda. Research is carried out at Ganga Darshan, in India, and by centres around the world. The effects of yoga practices are under investigation, as well as the impact of certain yogic practices and yogic lifestyle on physical and mental imbalance. The invitation which Sri Swami Satyananda extended to the scientific and yoga communities remains open, and all are welcome to share their knowledge, understanding and findings of their research into yoga.

MESSAGE FROM SRI SWAMI SATYANANDA TO YOGA RESEARCH FOUNDATION



Yoga Research Foundation was founded in 1984 and now in 1989 the projects and plans which we had envisaged are finally taking a dynamic shape.

I am confident that the Yoga Research Foundation will provide a scientific interpretation of the practices of yoga. Research conducted all over the world has amply indicated this possibility.

Although I am not personally present on this occasion, my thoughts and my spirit are always with the activities of the Foundation, for this is one dream I have cherished.

Swami Satyananda

Introduction

Yoga Research Foundation: Volume Three, Basic Yoga Research 1989–2007, presents research studies on specific practices of Satyananda Yoga–Bihar Yoga. Yoga Research Foundation, Munger, Bihar, investigated the effects and benefits of certain practices on healthy subjects and on subjects suffering from illnesses of diabetes and the cardiovascular and respiratory systems.

The practices studied were kunjal kriya, neti and shankhaprakshalana from the hatha yoga shatkarmas. In some studies, experiments were carried out in regard to the different salt content in the water used. In this way, the most suitable methods were explored for the practitioner.

From the pranayama practices, the effect of ujjayi, bhramari and nadi shodhana were observed. Parameters included blood pressure, pulse-rate and swara. Effects on the mental and emotional wellbeing of subjects were observed which included change in mood, peacefulness, alertness and energy levels. Thereby the interrelation of body and mind in each individual has been firmly established.

The group of twelve asana, known as *surya namaskara*, salutation to the sun, was studied applying various parameters such as general physical wellbeing, posture, change of swara, menstrual complaints and self-confidence.

The study on the practice of yoga nidra was conducted in relation to blood pressure and the possible reduction of high

blood pressure. The second study of yoga nidra was carried out with a group of school children. The aim was to establish the difference between the practice of yoga nidra and conventional sports and games in regard to the development of children's creativity.

The research projects of this present volume were carried out at the Bihar School of Yoga, Ganga Darshan, Munger, Bihar, with participants of various courses conducted on the campus: three-week Health Management Course, one-year Sannyasa Training Course and Post Graduate courses of one and two-year duration. Members of the Yuva Yoga Mitra Mandal also participated in some of the research projects. Other studies were conducted in Bhopal and Satna, Madhya Pradesh, India.

The influence of ashram environment and the yogic lifestyle is no doubt a positive contributing factor to the research results. This however only validates the claim that the full benefit of yoga can be experienced if the practices are complemented by changes in one's lifestyle. The research findings are an indication of how certain yogic practices can assist in developing the three aspects of yogic health management: the preventive, curative and promotive aspects of total health.

The number of participants and the duration of the research do not suffice to make any conclusive statement on the benefits of yoga practices. Yet, even the basic research carried out over these years with such varied groups of subjects is encouraging and gives a positive idea of the possibilities of well-known and easily accessible yogic practices.

Excerpts from the teachings of Swami Sivananda Saraswati, Swami Satyananda Saraswati and Swami Niranjanananda Saraswati have been included. They provide an understanding of the deeper meaning and purpose of the practices studied in this volume. For it was known to masters of all times that yoga has an impact and influence not only on the condition of the physical body but even more so on

the mind and emotions of the individual. The purpose of yoga is and always has been multidimensional.

Yoga embraces the entire range of human existence. From the gross physical dimension to the experience of the transcendental, spiritual realm all is possible with this human body and within this human life. Yoga is a process of refining and expanding perception, interaction and experience. It is not separate or isolated from one's day-to-day life. On the contrary, it enhances the quality of the practitioner's life. Once yoga is experienced and expressed as harmony, balance and peace, it becomes and is lived as a lifestyle.

Whether it be a shatkarma, pranayama, asana or relaxation practice the benefits are far-reaching. Within each practice lies hidden a treasure to be discovered, used and applied by each practitioner. The saying 'An ounce of practice is worth more than tons of theory' is the essence of every aspect of yoga. We hope that this volume may inspire yoga aspirants to investigate and explore for themselves the wealth of *yoga vidya*, the science of yoga.

Sri Swami Satyananda emphasized that research can be carried out in a simple manner and with few or no devices. According to him every individual yoga practitioner can be a researcher and use his body and mind as a laboratory.

For the suggested practices one should refer to *Asana Pranayama Mudra Bandha* of Yoga Publications Trust and seek the guidance of a competent yoga teacher. Yoga does not replace prescribed medication. The advice of one's medical practitioner must be followed and any change of one's condition discussed accordingly.

Understanding Statistics

Statistics are a play of numbers. One should know how to interpret the numbers. If wrongly presented to a person with little knowledge of statistics, the reading will lead to wrong conclusions.

The following brief description of terms is meant to help the layperson understand the intricacies of statistics as used by Yoga Research Foundation.

RESEARCH DESIGNS

Pre-post design: The same set of subjects are observed for a given parameter (example: blood pressure) before and after an intervention (example: 5 rounds of surya namaskara at medium speed). The observations are then compared using appropriate statistical methods.

Repeated measure trial: The subjects are observed once or more frequently during the trial period and not only at the beginning and end of the trial.

Controlled trial: One group of subjects are observed for a given parameter before and after an intervention; another similar group of subjects are observed in the same way but without any intervention. The two groups are then compared using appropriate statistical methods.

The first group is known as the experimental group (also known as yoga group in studies conducted by Yoga Research Foundation). The second group is known as the control group. The control group instead of having no intervention in some research studies may have another comparable intervention (example: asana versus physical exercise).

Random controlled trial: The subjects are assigned to either the experimental group or the control group at random, not selectively.

BASIC CONCEPTS

Hypothesis: It is a statement that describes the expected result of a research study (example: regular practice of ten minutes of ujjayi pranayama will reduce systolic pressure by 10 mmHg in a hypertensive person).

When the expected results of a research study are not specific they are called the ‘aims’ of the study (example: effects of ujjayi pranayama on blood pressure in hypertensive subjects).

Null hypothesis: It is a hypothesis that is directly counter to what one hopes to show (example: stressed individuals do not differ from normal individuals in aberrant behaviour).

Sample size (n or N): This refers to the total number of subjects under observation.

MEASURES OF ANALYSIS

Mean score: It is an arithmetic average of a set of scores.

Percentile: It refers to the point below which a specified percentage of observations falls.

Median or 50 percentile score is the score corresponding to the point having 50% of the observations below it when

observations are arranged in numerical order. Therefore, if scores were to be arranged by ranking, the mid-point ranking is the median.

25 & 75 percentile scores is the score corresponding to the point having 25% & 75% of the observations below it respectively when observations are arranged in numerical order.

Standard deviation: It is a score that depicts how individual or group scores are dispersed around the mean score; the smaller the standard deviation, the more closely clustered the scores are to the mean score, or the more uniform the group.

A high standard deviation score indicates that individual scores differ widely from each other.

When calculating significance, the standard deviation is used as the denominator (divisor). Therefore, the higher the denominator, the greater the nominator is needed to get the same result. That means that if the standard deviation score is high, a greater degree of change is needed in the individual scores to make the result significant.

Significance: This refers to the probability with which a hypothesis might be rejected when it is in fact correct. In other words, the significance level indicates that there is insufficient reason to believe the hypothesis is incorrect.

The smaller the number, the greater the significance. Usually a significance value of 0.01 or 0.05 or less is acceptable. It means that there is 1 (or 5) in 10,000 chance of the concerned hypothesis to be wrong when it is actually correct.

Factors influencing significance

1. Actual difference in values between two observations: There is a direct influence between the difference in values and significance. Therefore, the greater the difference between the pre-reading and the post-reading, the higher will be the significance.
2. Magnitude of the sample variance: The degree to which the individual observations differ from each other. There

is an inverse influence between the difference in values and significance. Therefore, the greater the sample variance, the less significant the results.

3. Sample size: There is a direct influence between sample size and significance. Therefore, the larger the sample group the greater the significance.

However, this can be misleading. If the sample size is enormous, a small change will be shown as significant. For example, in a group of 600 subjects with high blood pressure the reduction of blood pressure from 158 to 156 mmHg will be shown statistically as significant, but clinically it is insignificant and means nothing to the doctor or patient.

Similarly, if the sample size is too small, a moderate change can be statistically insignificant but indicate a useful change. Indeed, the study must be repeated with a larger sample to come to a final conclusion.

4. Chosen level of significance: Usually it is either 0.01 or 0.05. The lower the chosen level of significance, the better the probability that the hypothesis is in fact correct.

Magnitude of effect

To nullify the effects of influencing factors a measure called 'magnitude of effect' is calculated. It is a measure of the degree to which variability among observations can be attributed to interventions. It is a measure used to counteract violations in assuming significance.

'Eta squared', 'Omega squared', 'Effect size' are some of the statistics used to measure magnitude of effect.

Yoga Research Foundation uses 'Eta squared' to express the magnitude of effect. The higher the value of 'Eta squared', the more relevant is the result. A value that is greater than 0.2 is considered acceptable.

Methods of determining significance

1. *Student's t test (t test)*: It is used in pre-post type research designs involving two groups of subjects.

One-tailed t test: The one-tailed t test rejects only one tail of data distribution, the extreme lower end. It is used with homogeneous samples, in cases where the data is more or less equally distributed along the bell graph/on both sides of the mean value.

Two-tailed t test: The two-tailed t test rejects extreme results on both tails of data distribution. It is used in cases where the mean and median are very close together, i.e. when the research sample is not homogeneous.

2. *F Value:* It is commonly used when repeated observations are made over a period of time for a parameter in a sample. It is calculated using a general linear model, repeated measures. It is also used when the experiment involves more than two groups, e.g. yoga group, exercise group, no intervention group. It is calculated using ANOVA (Analysis of variance).

The cut-off value of F statistic at which the hypothesis is accepted (in technical terms, the null hypothesis is rejected) depends upon degree of freedom (df). Then after computation it is expressed as significance.

Degree of freedom (df): It is usually taken as one less than the number of observations in the sample.

3. *Analysis of variance (ANOVA):* This is a statistical technique for testing differences in the means of several groups, not just two as in the t test.

Power: This is the probability of correctly accepting a valid hypothesis (in technical terms, correctly rejecting a false null hypothesis). It denotes the reliability of the findings. The value 1 shows 100% reliability, 0.5 shows 50% reliability. A very good reliability or power is 0.8 and above.

DISPLAYING DATA

Bar graph: This is a graphical representation in which the frequency of occurrence or quantity of different variables on the X axis (horizontal axis) is represented by the height of the bars.

Line graph: It refers to a graphical representation in which the Y axis (vertical axis) values corresponding to different values of the X axis (horizontal axis) are connected by a line. In this way its use is the same as the bar chart. It is also useful for time-series data.

Boxplot graph (box and whisker plot): It is a graphical representation of the dispersion and variability of a sample. The lower hinge of the box denotes 25 percentile, the upper limit or hinge, 75 percentile and the middle line 50 percentile or median.

Components of a boxplot graph

1. *H-spread:* It refers to the area between the two hinges (the actual box).
2. *Hinges:* They are those points that cut off the bottom and top quarter of a distribution. They display the middle 50% of the scores.
3. *Whisker:* It is the line extending from the upper and/or lower hinge representing observations less than 25 percentile or more than 75 percentile. A whisker is not longer than 1.5 times the H-spread.
4. *Outlier:* It is an observation lying outside the limit of the whisker. In the research studies conducted by Yoga Research Foundation all outliers have been hidden from the graphs.

LIST OF ABBREVIATIONS

n	number of subjects in a research study
BMI	Body Mass Index or Basal Metabolic Index
SBP	Systolic Blood Pressure (blood pressure during rhythmical contraction of the heart)
DBP	Diastolic Blood Pressure (blood pressure during dilation of the heart and arteries)
Kg/m ²	kilogram/square metre (e.g. body weight in kilogram divided by height in metre squared)
mmHg	millimetre of mercury (Hg), unit used to express blood pressure
h/o	history of
DM	Diabetes Mellitus
HBP	High Blood Pressure
Std dev	Standard deviation
mg%	milligram %
NIDDM	Non-Insulin Dependent Diabetes Mellitus
Blood sugar F & PP	Fasting & Post Prandial (two hours after a meal)
Bl. Glu. F	Blood Glucose/Sugar Fasting
Bl. Glu. PP	Blood Glucose/Sugar Post Prandial (two hours after a meal)
HbA1c	Glycosylated Haemoglobin (blood test overall control of blood sugar over a period of three months just prior to the test)
HDL	High Density Lipoprotein, a component of cholesterol
LDL	Low Density Lipoprotein, a component of cholesterol
IHD	Ischemic Heart Disease (heart disease due to inadequate coronary blood supply to the heart)
ICMR	Indian Council of Medical Research

Shatkarmas

Introduction

Before awakening the kundalini, one must have purity of body, purification of nadis, purity of mind and purity of intellect. For the purification of the body, the hatha yoga shatkarmas are prescribed.

—Swami Sivananda Saraswati

Hatha yoga, as described in the early Yoga Upanishads, was made up of the shatkarmas and is a precise and systematic science. *Shat* means ‘six’ and *karma* means ‘action’; the shatkarmas consist of six groups of purification practices. The aim of hatha yoga, and therefore of the shatkarmas, is to create harmony between the two major pranic flows, ida and pingala, resulting in physical and mental purification and balance. There are six main groups of *shatkarmas*, or yogic cleansers:

1. *Neti*: nasal cleansing
2. *Dhauti*: cleansing of the digestive tract
3. *Nauli*: rolling the abdominal muscles
4. *Basti*: colon cleaning
5. *Kapalbhati*: purification and vitalization of the frontal brain
6. *Trataka*: blinkless gazing at one point.

The body functions along simple lines. Just as a machine produces wastes, the physical body continuously produces wastes. These wastes are of three types: mucus, gas and

acidity. If the body is internally cleansed from time to time, the excess of these three metabolic products is removed, and their formation is regulated and balanced. Perfect health can then be maintained.

Yogic science gives as much importance to certain cleansing processes as it does to asanas or pranayamas. They are important from the point of view of physical and mental health. These simple techniques are highly valuable in healing internal disorders. Without regular cleansing of the body's internal systems, maximum benefits from yoga practices will not be gained. When the body is free, the mind also functions properly.

The shatkarmas specifically increase the vital capacity of the practitioner. They were never designed for therapy alone, but to create harmony in the body and mind and to prepare one for further practices. As they bring about smooth and perfect functioning of the bodily systems, it is inevitable that through their practice the mind will become free from turbulence and disturbances and thus be better able to concentrate and move towards *dhyana*, meditation.

The effects of shatkarmas can be summed up in one word – purification. When the systems of the body have been purified, the overall result is that energy can flow freely through the body. One's capacity to work, think, digest, taste, feel and experience increases, and greater awareness develops. It is no wonder that the yogis who have achieved perfection and know the real extent of human capacity, regard the shatkarmas with great esteem.

—*Swami Satyananda Saraswati*

In the proper application of yoga, everyone must go through the cleansing techniques of hatha yoga to rid the body of the toxicity accumulated at both the gross and subtle levels.

Cleaning the body internally is as important as cleaning the body externally. Cleaning the body is necessary in order

to experience harmony and balance inside. Cleansing the body directly affects how the mind is experienced. If one's internal body is unclean, a certain disharmony is felt in the mind.

—*Swami Niranjanananda Saraswati*

NETI

Neti is for the purification of the nostrils. The nostrils must always be kept clean. Unclean nostrils lead to irregular breathing, and irregular breathing makes one sick. Head colds and hay fever are cured with neti.

—*Swami Sivananda Saraswati*

Neti is the first shatkarma of hatha yoga. It is a practice designed to clean the nasal passages, reduce the amount of waste material deposited there and allow a greater amount of oxygen to pass into the brain. Neti cures infections, colds, cataracts, sinusitis, migraine, infection of the adenoids, polyps and inflammation of the nasal membrane. Neti also activates the brain: neti is the cleaning of the nasal passage in order to awaken sushumna. It leaves a general feeling of lightness and freshness in the head, and removes drowsiness. The benefits of neti kriya are many.

—*Swami Satyananda Saraswati*

Neti is for the head region. The benefits of neti are for problems related to the nose, eyes and ears. The nose is connected to many different nerve endings. The optic nerves are connected with the visual area of the brain, the auditory nerves are connected with the hearing part of the brain, and the olfactory nerves with the sense of smell. All these nerves are located in and around the nostrils and the upper throat.

In the practice of neti, as the water goes through the mucous membrane, it touches all these nerve endings on its way and stimulates them, directly or indirectly. The temperature, force and flow of water stimulate them, causing many people in the initial stages of practising neti to feel tears come to their eyes. Neti removes the impurities, the dust and dirt that are absorbed by the membrane, the excess dryness or wetness, and provides a proper healthy structure to the membrane.

—*Swami Niranjanananda Saraswati*

KUNJAL KRIYA

The stomach should be kept clean and in the healthiest possible condition if it is to retain its efficiency and remain free from disease. Kunjal kriya creates this clean, healthy condition, as well as removing acidity. It is therefore a panacea for both those who have digestive ailments and those who want to maintain good health.

Kunjal kriya is a simple practice and all that is vomited is salty water containing impurities from the stomach. As such there is no unpleasant taste, smell or nausea as there is during times of sickness. It is these uncomfortable sensations that people find repulsive. Without these disagreeable factors the practice of kunjal kriya becomes simple and is not at all unpleasant. The biggest obstacle in trying this practice is one's mental concept of what is involved.

—*Swami Satyananda Saraswati*

Kunjal kriya helps a healthy person to remain free from disease. It cleans the upper digestive tract, has a profound effect on the nervous system, and is therefore beneficial for general health. It is especially useful for people suffering from kapha and pitta disorders.

This practice washes the digestive system from stomach to mouth, helping remove and prevent diseases caused by the accumulation of toxic matter and general impurities in this region. It helps eradicate bad breath, phlegm in the throat and some types of sore throat. Salty water reduces the secretion of acid by the glands in the stomach, enhancing the stomach's digestive efficacy.

Asthmatics obtain great relief from this practice. Kunjal can be practised at the time of an asthma attack. In this situation it is imperative that the stomach is completely filled with water to obtain best results. When the person starts vomiting, the airways, which are tight and contracted in an asthma attack, are relaxed, providing immediate relief.

Kunjal kriya is an exceptionally effective technique for relieving pent-up, unexpressed emotions which burden the heart and cause feelings of heaviness within the body and mind, particularly around the chest, diaphragm and abdomen. The technique is especially useful for releasing emotional blocks created by inner and external tension, conflict and pressure. It brings about a feeling of emotional lightness, clarity and peace, which in turn supports one's physical health.

—Swami Niranjanananda Saraswati

SHANKHAPRAKSHALANA

In the practice of *shankhaprakshalana*, also known as *varisara dhauti*, five litres or more of water are drunk and evacuated through the anus. It is a process that must be learned under an expert. In the term *shankhaprakshalana*, the word *shankha*, meaning 'conch', is used as the shape of the stomach is shaped like the conch. *Shalana* means 'to wash'. *Prakshalana* means 'to wash completely'.

The Sanskrit word *laghoo* means 'short', 'condensed' or 'concise'. Therefore, the term *laghoo shankhaprakshalana*

means, the short intestinal wash. Laghoo shankhaprakshalana is intended to encourage normal functioning of the intestines. People with digestive problems such as constipation, flatulence, acidity, indigestion and other digestive maladies are advised to practise this technique. Laghoo shankhaprakshalana is an excellent method of purifying the body, and of preventing or helping to remove a diverse number of ailments.

Shankhaprakshalana, if it is properly done, is the easiest of the practices. Nevertheless, preparation is important. Before doing shankhaprakshalana the yoga postures should be practised for some time, and kunj and neti kriyas.

—*Swami Satyananda Saraswati*

The practice of shankhaprakshalana cleans both the small and large intestines. Shankhaprakshalana is the modern method of varisara dhauti, in the sense that it is acceptable to all and can be practised by everyone, providing there is an awareness of the appropriate climatic and dietary restrictions that have to be followed after the practice.

There are two variations of this practice. One is called *laghoo shankhaprakshalana (LSP)*, the short form, in which six glasses of warm saline water are drunk, two at a time, followed by the performance of five asanas (*tadasana*, palm tree pose; *tiryak tadasana*, swaying palm tree pose; *kati chakrasana*, waist rotating pose; *tiryak bhujangasana*, twisting cobra pose; *udarakarshanasana*, abdominal stretch pose) which loosen up the intestines and allow the water to pass through.

The second variation is called *poorna shankhaprakshalana (PSP)*, the full form, in which a total of sixteen or more glasses of water are drunk in combination with the practice of the same specified asanas. The saline water flushes the whole system by creating pressure, and thoroughly cleans out all the accumulated particles from the intestines. This process also removes the entire mucous lining from the

intestine, which makes the digestive system highly sensitive and also increases mental sensitivity.

The effects of shankhaprakshalana include stimulation of the nervous system, improvement of the digestive function, elimination of toxins from the entire system and sensitization of the nadis that link the chakras together. The state of physical purification also helps the pranamaya kosha to reorganize and restructure the flow of prana in the body. The increased sensitivity in the mind and energy is due to the effect of the practice on the pranic body. For this reason many people are physically tired after performing shankhaprakshalana, but still have a lot of energy within them. There is no heaviness in the body; the whole body feels light, as if it is floating.

—*Swami Niranjanananda Saraswati*

Psychophysiological Effects of Kunjal Kriya in Normal, Hypertensive and Asthmatic Subjects, 2000–2006

Summary

In **Study 1** on 70 healthy subjects, kunjal had no significant immediate effect on blood pressure (BP) but the delayed response showed a significant fall (significance 0.001). The pulse-rate increased significantly (significance 0.001) and then levelled out. Peak expiratory flow rate (PEFR), signifying state of relaxed airways, improved marginally after kunjal and kept improving further for the next few hours (significance 0.01). The rise in body temperature was less than significant. Contrary to expectations, the respiratory rate increased to a small degree. Sushumna and pingala activities were dominant after kunjal.

In **Study 2** on 21 hypertensive subjects, both systolic and diastolic BP rose after kunjal but showed tendency to fall after neti. By the end of one hour they were significantly lower (significance 0.001) than pre level. The pulse-rate rose significantly (significance 0.001) and stayed high.

In **Study 3** on 17 asthmatics, kunjal showed significant improvement in PEFR (significance 0.03), signifying a relaxed state of airways.

Introduction

Kunjal kriya, or kunjal in short, is a cleansing practice of hatha yoga belonging to the vaman hrid-dhauti class of shatkarmas. It works on the chest region. It cleanses the upper gastrointestinal (GI) tract, the oesophagus and the stomach of excess mucus and acid. It liquefies the mucous secretions in the respiratory system and widens the bronchial diameter facilitating expulsion of collected secretions. It extroverts the mind and excites the nervous

system in the beginning but at the end relaxes and calms the mind.

During the act of kunjaj, the direction of downward flowing apana vayu in the pelvic area is reversed and together with samana vayu in the navel region, it boosts the upward movement of prana vayu in the chest area thus forcefully expelling the stomach contents through the mouth. The strong pranic movements cause temporary sympathetic stimulation followed by longer lasting rebound parasympathetic response.

Initial sympathetic over-activity is expected to cause rise in pulse-rate, systolic and diastolic BP and respiratory rate, dilatation of bronchi leading to increased PEFR, rise in body temperature, right nostril or pingala dominance, extroversion and anxious alertness. The later parasympathetic response is expected to cause fall in pulse-rate, both the BPs and respiratory rate, fall in body temperature, left nostril or ida dominance, introversion and a relaxed, at times drowsy, state of mind.

The Yoga Research Foundation (YRF), Munger, Bihar, conducted a few studies to observe some of the physiological effects of kunjaj kriya in healthy as well as hypertensive and asthmatic subjects.

Study 1

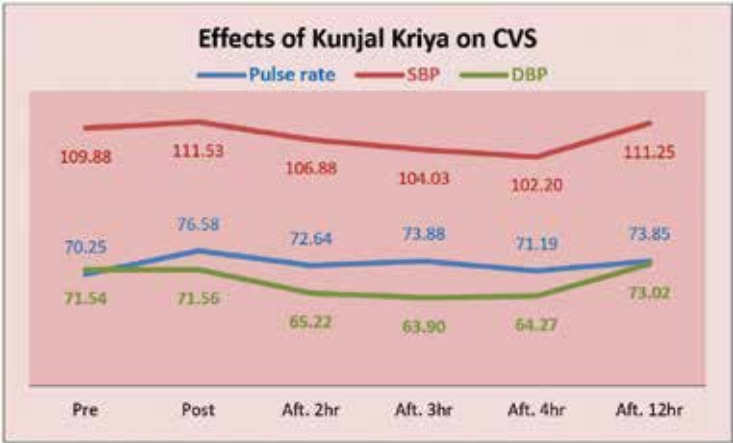
Fifty-nine male as well as female, young to middle-aged healthy participants in the Sannyasa Course of 2001 at the Bihar School of Yoga (BSY) were observed for the physiological effects of kunjaj kriya without jala neti for up to 12 hours. They showed significant increase in pulse-rate (0.001) just after kunjaj kriya. It gradually came down over the next four hours. The systolic and diastolic BP showed no significant rise after kunjaj kriya but statistically significant decrease (0.001) was noted between 2 and 4 hours after the practice. The Peak Expiratory Flow Rate (PEFR) marginally rose after the practice and kept improving slowly and gradually reaching peak at four hours (significance 0.01)

after the practice and maintaining the improvement even after 12 hours. The respiratory rate and body weight did not show any substantial change. The body temperature increased after the practice within normal range and stayed raised for three hours. See Table 1 and the accompanying graphs. The practice had balancing effect on swara while maintaining pingala activity. See Table 2 and the accompanying graph.

Table 1: Physiological effects of kunjla kriya

n=59	Pre	Post	Aft 2hr	Aft 3hr	Aft 4hr	Aft 12hr
<i>Pulse-rate</i>	70.25	76.58*	72.64	73.88**	71.19	73.85*
<i>SBP</i>	109.88	111.53	106.88**	104.03*	102.20*	111.25
<i>DBP</i>	71.54	71.56	65.22*	63.90*	64.27*	73.02
<i>PEFR</i>	417.80	422.37	432.20	431.36	447.63***	438.98
<i>Resp. rate</i>	21.71	22.81	23.22	22.76	22.95	22.58
<i>Body weight</i>	54.35	54.73	54.53	54.42	54.34	54.49
<i>Body temp.</i>	35.94	36.44	36.50	36.51	36.40	36.62

*significant at 0.001; **significant at 0.005; ***significant at 0.01



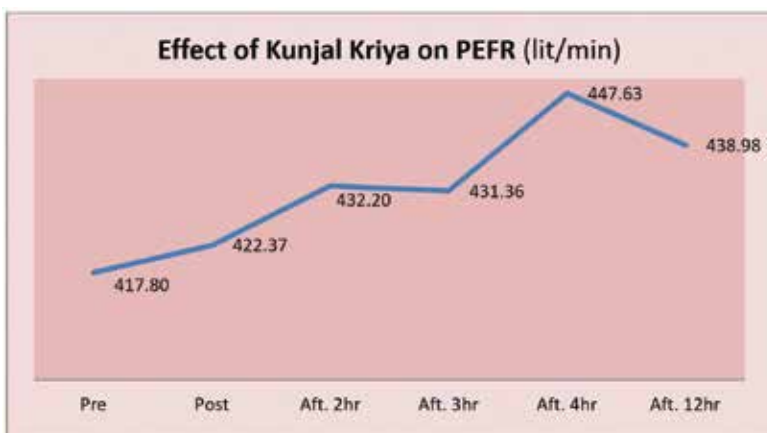
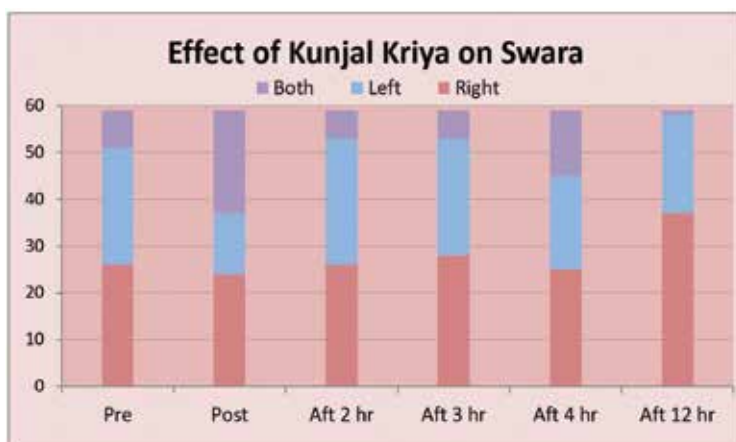


Table 2: Effect of kunjal kriya on swara pattern

n=59	Pre	Post	Aft 2 hr	Aft 3 hr	Aft 4 hr	Aft 12 hr
<i>Right</i>	26	24	26	28	25	37
<i>Left</i>	25	13	27	25	20	21
<i>Both</i>	8	22	6	6	14	1

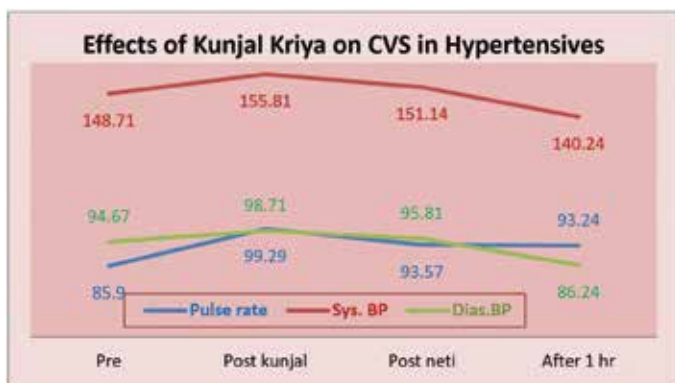


Study 2

Twenty-one hypertensive participants of the Health Management Course at the Bihar School of Yoga in March–April 2004 were observed for the cardiovascular impact of kunjal kriya and jala neti for one hour after the practice. After kunjal kriya the pulse-rate increased by both statistically and clinically highly significant level (0.001); it partially came down after the practice of neti and stabilized at that level. Both the systolic (SBP) and the diastolic (DBP) blood pressures abruptly went up after kunjal, partially came down after neti and at the end of one hour they both were significantly lower than their ‘Pre’ levels (0.001). It is worth noting that **the cardiovascular system (CVS) responses in hypertensive subjects are very different from the normal healthy persons** compare with Study 1. It is interesting to note that out of **21 persons, 19 showed a rise in pulse-rate** (rise of 10 or more in 13 subjects), **13 showed rise in systolic pressure** (rise of 10 or more in 7 subjects), and **14 showed a rise in diastolic pressure** (rise of 10 or more in 5 subjects) just after kunjal kriya. **The range of rise in pulse-rate was 4 to 36 per minute, in SBP it was 4 to 41 mmHg and in DBP it was 1 to 27 mmHg.**

Table 3: Cardiovascular effects of kunjal kriya in hypertensives

n=21	Pre	Post kunjal	Post neti	After 1 hr
<i>Pulse-rate</i>	85.9	99.29*	93.57*	93.24*
<i>Systolic BP</i>	148.71	155.81**	151.14	140.24*
<i>Diastolic BP</i>	94.67	98.71**	95.81***	86.24*
*significant at 0.001; **significant at 0.05; ***significant at 0.05 as compared with post kunjal DBP <u>only</u>				

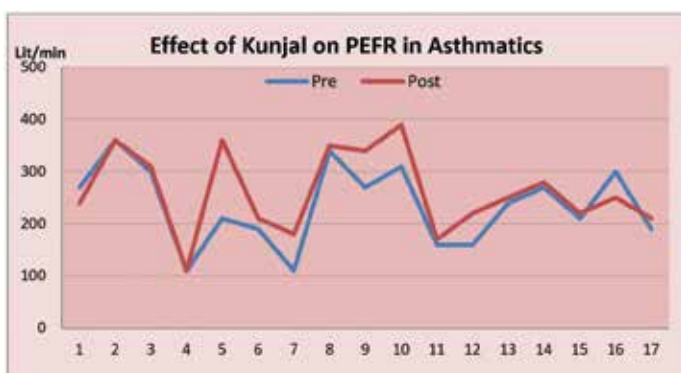


Study 3

In year 2006–2007, in a small study at Bharat Heavy Electricals, Ltd (BHEL) in Bhopal, India, on 17 asthmatics, the immediate effect of kunjal kriya on PEFR was observed. It showed a significantly beneficial effect (0.03).

Table 4: Effect of kunjal kriya on PEFR in asthmatics

n=17	Pre	Post
PEFR	235.29	261.76
t test		0.0334



Conclusion

- The pulse-rate rose after the practice of kunjla kriya in healthy individuals as well as in hypertensive subjects, but in the latter, the rise was much bigger.
- There was no significant change in post values of SBP and DBP in the healthy subjects, but in hypertensive subjects both SBP and DBP showed a significant increase. In both the groups SBP and DBP gradually came down to less than pre values.
- In healthy subjects PEFIR improved after the practice of kunjla kriya and continued to improve for the next 12 hours. In asthmatic subjects the immediate improvement was much larger. They were not observed for longer periods.
- The swara pattern showed balance of both swaras with incidence of pingala remaining unaltered in this study, contrary to the expectation.
- Parameters of respiratory rate and body weight did not show much change.
- Body temperature increased within normal range after the practice and stayed raised for 3 hours.

Physiological Effects of Laghoo Shankhaprakshalana (LSP) in Healthy Subjects, Hypertensive and Non-hypertensive Patients, 2000–2003

Summary

Study 1 on 55 young healthy subjects showed a rise in pulse-rate and systolic and diastolic BP as the immediate effect of laghoo shankhaprakshalana (LSP). Both BP measures, though, significantly came down later. There was no water retention as predicted through change in body weight. Peak Expiratory Flow Rate (PEFR) improved only marginally. There was pingala dominance during LSP practice but the delayed response was ida dominance.

Study 2A on 55 normotensive patients with various ailments showed a rise in PR, SBP and DBP as in Study 1, but with higher magnitude and subsequent fall of much smaller magnitude. PEFR deteriorated in 17 asthmatic subjects. Swara pattern was maintained all through.

Study 2B on 94 hypertensive patients with various ailments showed similar changes as in study 2A, but there was much greater fall in both BP two to four hours after LSP.

Study 2C on 28 patients (10 hypertensives) attending the Yoga Research Centre run by Kasturba Hospital, BHEL, Bhopal in collaboration with the Bihar School of Yoga showed the combined effect of sequential practices of LSP, kunjla and jala neti. There was a rise in pulse-rate after LSP and kunjla, with a tendency to fall after neti. The systolic and diastolic BP increased marginally after LSP in people with normal BP but decreased after neti. The systolic and diastolic BP decreased

in hypertensive group after each of the three practices. Body weight remained steady showing no water retention.

Introduction

Shankhaprakshalana is a varisara antar dhauti class of cleansing practice, shatkarma, of hatha yoga. It cleanses the stomach, small intestine and large intestine of excess bile and mucus. It expels faecal matter from the large intestine. In Satyananda Yoga two versions of this practice are practiced. Poorna shankhaprakshalana (PSP) is the classical version and laghoo shankhaprakshalana (LSP) is the shorter version, in which only six glasses or 1.75 to 2 litres of warm saline water are used. After drinking 2 glasses of warm saline water, 5 asanas (tadasana, tiryak tadasana, kati chakrasana, tiryak bhujangasana, udarakarshanasana) are performed 8 times each. This is repeated 3 times (see page 73).

LSP encourages gastro-intestinal (GI) motility, clears bowels of constipation and stimulates secretion of digestive juices. A part of the saline water gets absorbed into the circulatory system and is eventually thrown out of body via kidneys. It thus flushes and stimulates the kidneys. It relaxes in a gentle way and encourages a 'letting go' attitude. There may be initial sympathetic stimulation of a small degree due to physical exertion, but overall there is parasympathetic activity induced by GI motility. This causes related effects on various organ systems and mind.

The Yoga Research Foundation (YRF), Munger, Bihar, conducted a few studies to observe some of the physiological effects of LSP on healthy subjects as well as subjects with health problems.

Study 1

Fifty-five young healthy participants in the Sannyasa Course of 2001 at the Bihar School of Yoga were studied for the effects of LSP on the cardiovascular system, measured as pulse-rate and BP, water retention measured as gain in body weight, PEFr and pranic effect measured by the swara pattern. All

Table 1: Physiological effects of LSP in healthy subjects

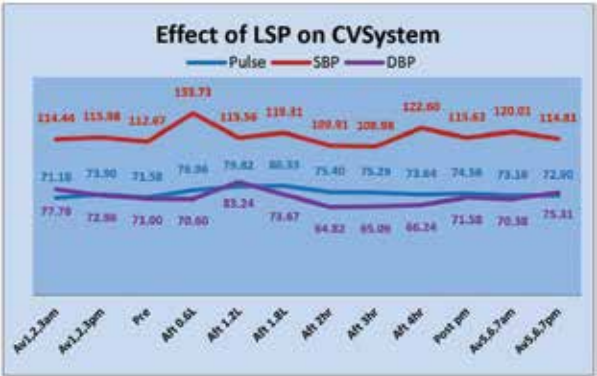
n=55	Av: days 1, 2, 3 (am)	Av: days 1, 2, 3 (pm)	Pre	Aft 0.6l	Aft 1.2l	Aft 1.8l	Aft 2hr	Aft 3hr	Aft 4hr	Post pm	Av Days 5,6,7 am	Av Days 5,6,7 pm
<i>Pulse</i>	71.18	73.90	71.58	76.96	79.82	80.33	75.40	75.29	73.64	74.56	73.16	72.90
<i>SBP</i>	114.44	115.98	112.67	133.73	115.56	119.31	109.91	108.98	122.60	115.62	120.01	114.81
<i>DBP</i>	77.78	72.96	71.00	70.60	83.24	73.67	64.82	65.09	66.24	71.58	70.38	75.31
<i>Weight</i>	55.65	55.68	55.12	55.52	55.93	56.21	55.40	55.49	55.43	55.56	55.64	55.58
<i>PEFR</i>	397.21	426.39	426.91	437.18	426.49	439.36	441.36	445.27	442.27	439.16	413.15	436.70

the parameters were recorded in the morning and evening for three days prior to and after the day of LSP, and several times during the practice and in the evening of that day.

As shown in Table 1, the pulse-rate rose during the practice and later gradually decreased but did not go lower than pre values (F 16.713, significance 0.000). The SBP and DBP both rose during the practice but decreased below pre level by the end of two hours and stayed low for a few hours (SBP – F 25.244, significance 0.000 and DBP – F 29.625, significance 0.000). The changes in pulse-rate, SBP and DBP were significant. There was no water retention in the body; no weight gain at two hours after the practice. PEFR very marginally improved during the practice but returned to pre values in the next three days. See Tables 1 and 1a and accompanying graph.

Table 1a: Test of significance for physiological parameters of LSP in healthy subjects

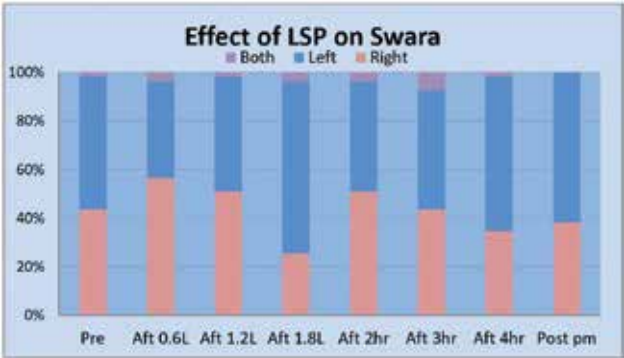
n=55	F	Significance	Partial eta squared	Observed power
<i>Pulse-rate</i>	16.713	0.000	0.236	1.000
<i>SBP</i>	25.244	0.000	0.319	1.000
<i>DBP</i>	29.625	0.000	0.354	1.000



The swara pattern showed pingala activation during the practice followed by strong ida dominance at the end of the practice. Initial physical activity stimulated pingala nadi and sympathetic nerves leading to a rise in BP and pulse-rate. But as the bowel peristalsis started due to the water moving forcefully down the gut, the parasympathetic nerves and, so, ida nadi became active. This is reflected in left swara and falling values of BP and pulse-rate at the end of LSP and up to three or four hours post-practice.

Table 2: Pattern of swara in LSP in healthy subjects

n=55	Pre	Aft 0.6l	Aft 1.2l	Aft 1.8l	Aft 2hr	Aft 3hr	Aft 4hr	Post pm
<i>Right</i>	24	31	28	14	28	24	19	21
<i>Left</i>	30	22	26	39	25	27	35	34
<i>Both</i>	1	2	1	2	2	4	1	0



Study 2A

In 55 participants of various health management courses between the years 2000 to 2002, the effects of LSP on the cardiovascular system, water retention measured as gain in body weight, and pattern of swara were studied. All the patient-subjects had normal BP. They had various

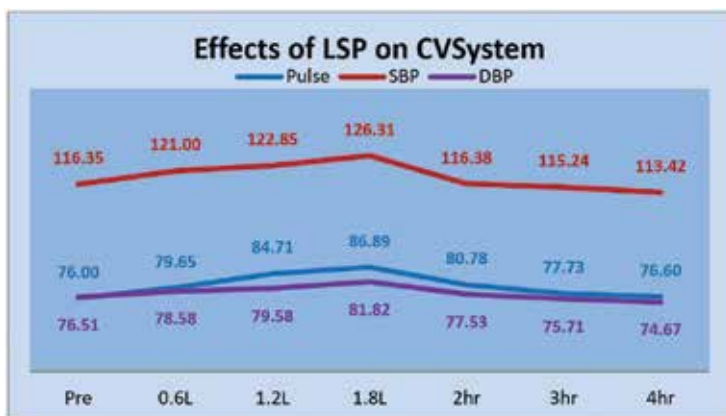
ailments: 19 were diabetic, 18 had digestive ailments, 8 had constipation and 10 were asthmatics. Study of their body weight showed that they took longer than four hours to regain their 'pre' body weight. The pulse-rate, systolic as well as diastolic BP increased during the practice of LSP but stayed within the normal range. This is the normal physiological response. They came down to pre level within 3 hours and even went below pre level to a small degree, reflecting a relaxed state and parasympathetic activity. The changes in pulse-rate, SBP and DBP were highly significant (SBP – F 37.926, significance 0.000; DBP – F 21.788, significance 0.000; PR – F 24.419, significance 0.000).

Table 3: Physiological effects of LSP in subjects with health problems

n=55	Pre	0.6l	1.2l	1.8l	2hr	3hr	4hr
<i>Pulse</i>	76.00	79.65	84.71	86.89	80.78	77.73	76.60
<i>SBP</i>	116.35	121.00	122.85	126.31	116.38	115.24	113.42
<i>DBP</i>	76.51	78.58	79.58	81.82	77.53	75.71	74.67
<i>Weight</i>	55.27	55.88	56.42	56.83	56.06	55.71	55.56

Table 3a: Test of significance for physiological effects of LSP in subjects with health problems

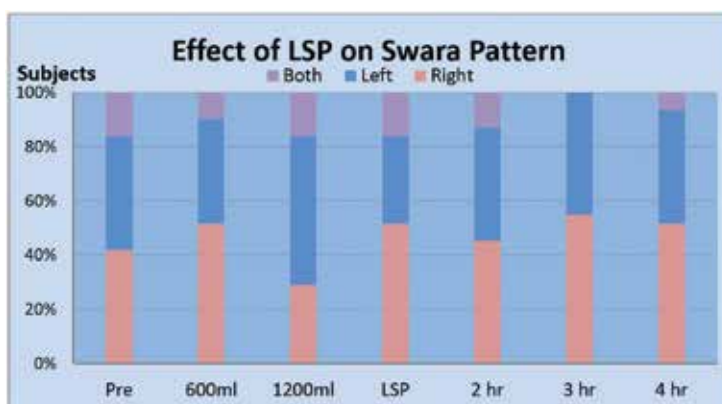
n=55	F	Significance	Partial eta squared	Observed power
<i>Pulse-rate</i>	24.419	0.000	0.311	1.000
<i>SBP</i>	37.926	0.000	0.413	1.000
<i>DBP</i>	21.788	0.000	0.287	1.000



In 27 subjects out of 55 swara pattern was studied. There was no pingala or sympathetic dominance to begin with. The pattern was more or less maintained throughout.

Table 4: Pattern of swara in LSP in subjects with diseases

n=27	Pre	0.6l	1.2l	1.8l	2hr	3hr	4hr
Right	11	14	14	14	14	15	16
Left	12	11	9	9	10	12	9
Both	4	2	4	4	3	0	2



In the same study, the effect of LSP on PEFR was studied on 10 asthmatics. It showed decline in PEFR as their abdomen got bloated with water but it came back to pre level within 2 hours as their bowels started expelling the abdominal contents.

Table 5: Effect of LSP on PEFR in asthmatic subjects

n=10	Pre	0.6l	1.2l	1.8l	2hr	3hr
<i>PEFR</i>	261	256	244	238	258	262

Study 2B

In a parallel study on 94 hypertensive participants in various health management courses at BSY between the years 2000 to 2003, the effects of LSP on the cardiovascular system, water retention measured as gain in body weight, and pattern of swara were studied. They had various ailments: 55 had only high BP and 39 had high BP in association with other ailments. Of these 39, 25 had diabetes, 7 had digestive ailments, 5 had asthma and 2 had hypothyroidism. Like the group of 55 patient-subjects with normal BP, after LSP they also showed highly significant rise in pulse-rate, and systolic and diastolic BP. The mean rise in BP was less as compared to the first group, and within two hours after the practice the BP reached below pre level and continued to decrease until the end of study time (4 hours). The body weight followed the same pattern as the first group but reached pre level earlier, by the end of 4 hours. PEFR was not studied in this group.

Sixty out of 94 subjects showed a rise in pulse-rate by 10 or more beats per minute (bpm), **maximum up to 46 bpm**, while 12 subjects showed a fall by 10 bpm or more, maximum up to 24 bpm. The fall in pulse-rate was mainly after the practice during rest time.

Fifty-six out of 94 subjects showed a rise in systolic BP by 10mmHg or more, **maximum up to 51mmHg**. Fifty-nine subjects showed a fall in SBP by 10mmHg or more,

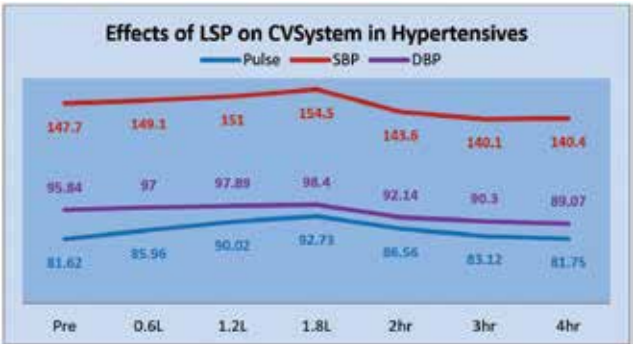
maximum up to 40mmHg. **Thirty-four out of 94 subjects showed a rise in diastolic BP** of 10mmHg or more, **maximum up to 30mmHg**. Forty-four subjects showed a fall in DBP by 10mmHg or more, maximum up to 31mmHg. The rise in SBP and DBP was mainly during the practice while the fall was mainly after the practice during rest time. Some subjects showed changes, in both rise and fall of BP.

Table 6: Physiological effects of LSP in hypertensive subjects

n=94	Pre	0.6l	1.2l	1.8l	2hr	3hr	4hr
<i>Pulse</i>	81.62	85.96	90.02	92.73	86.56	83.12	81.75
<i>SBP</i>	147.70	149.10	151.00	154.50	143.60	140.10	140.40
<i>DBP</i>	95.84	97.00	97.89	98.40	92.14	90.30	89.07
<i>Weight</i>	68.24	68.78	69.34	69.73	69.21	69.18	68.27

Table 6a: Test of significance for physiological parameters of LSP in hypertensive subjects

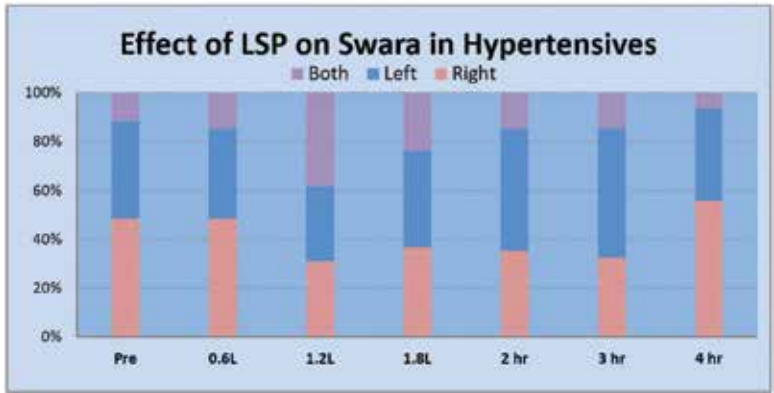
n=94	F	Significance	Partial eta squared	Observed power
<i>Pulse-rate</i>	58.626	0.000	0.387	1.000
<i>SBP</i>	47.840	0.000	0.340	1.000
<i>DBP</i>	40.220	0.000	0.302	1.000



In 68 subjects out of 94, the swara pattern was studied. There was pingala or sympathetic dominance to begin with. As the practice progressed, left swara, ida nadi or the parasympathetic nervous system became more dominant. This finding is in agreement with the findings regarding the cardiovascular system. This finding was different from the first group because this second group had higher sympathetic tone to begin with.

Table 7: Pattern of swara in LSP in hypertensive subjects

n=68	Pre	0.6l	1.2l	1.8l	2 hr	3 hr	4 hr
<i>Right</i>	33	33	21	25	24	22	35
<i>Left</i>	27	25	21	27	34	36	24
<i>Both</i>	8	10	26	16	10	10	4
<i>n. avail</i>	0	0	0	0	0	0	5



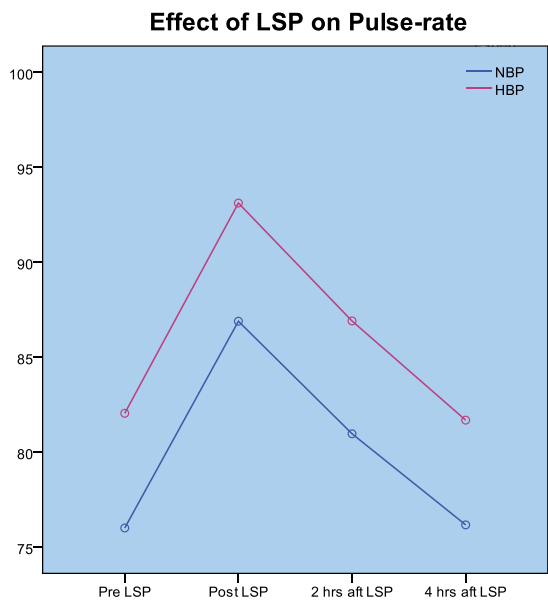
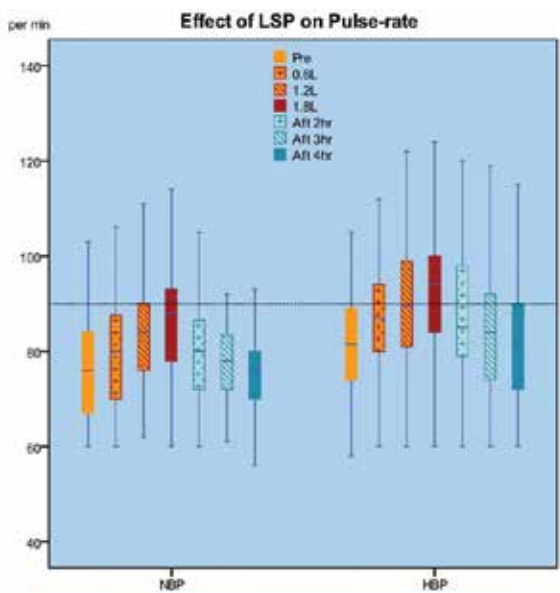
When compared with the group with normal BP, the changes in the group with high BP were more in magnitude (greater F values). The changes in pulse-rate were more or less parallel but systolic as well as diastolic BP definitely showed greater fall in delayed response. See Tables 8 and 9, and accompanying graphs.

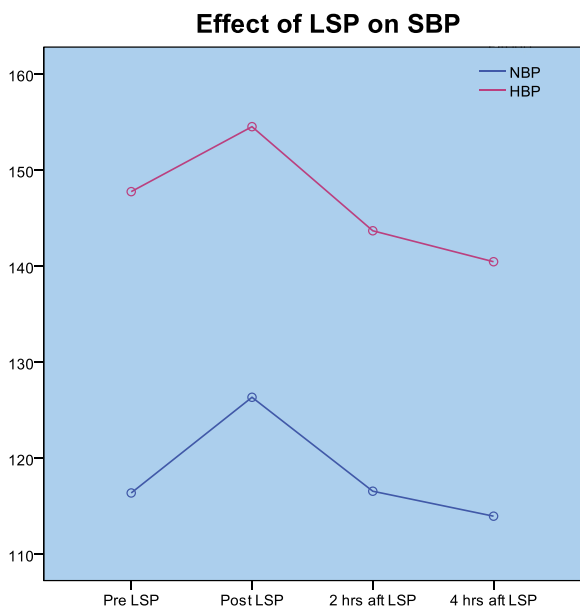
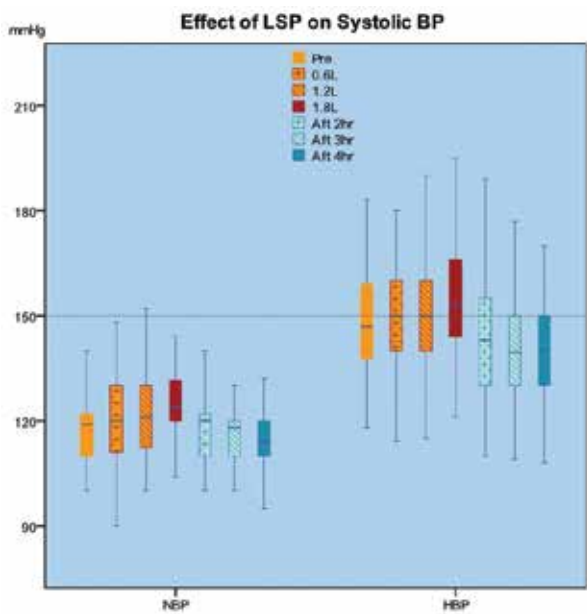
Table 8: Physiological changes in LSP in normal and hypertensive subjects

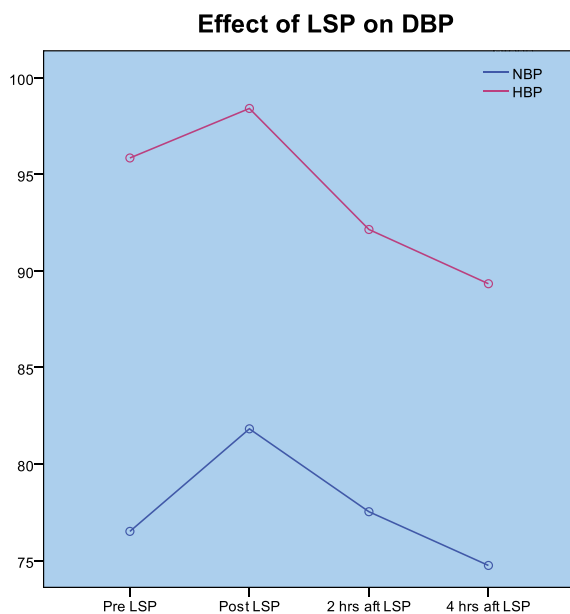
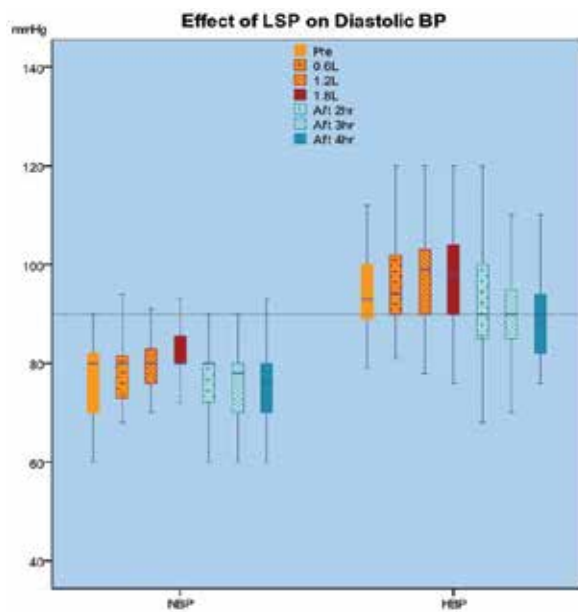
Group	Pre	0.6l	1.2l	1.8l	Aft 2hr	Aft 3hr	Aft 4hr	F	Signifi- cance	Partial eta squared	Observed power
										Pulse-rate	
<i>NBP</i> n=55	76.00	79.65	84.71	86.89	80.96	77.76	76.16	24.419	0.000	0.311	1.000
<i>HBP</i> n=94	82.04	86.43	90.47	93.12	86.90	83.97	81.68	58.626	0.000	0.387	1.000
										Systolic BP	
<i>NBP</i>	116.35	121.00	122.85	126.31	116.53	115.20	113.93	37.926	0.000	0.413	1.000
<i>HBP</i>	147.72	149.14	150.97	154.49	143.65	140.05	140.43	47.840	0.000	0.340	1.000
										Diastolic BP	
<i>NBP</i>	76.51	78.58	79.58	81.82	77.53	75.82	74.75	21.788	0.000	0.287	1.000
<i>HBP</i>	95.84	97.00	97.89	98.40	92.14	90.26	89.33	40.220	0.000	0.302	1.000
										Body weight	
<i>NBP</i>	55.27	55.88	56.42	56.83	56.06	55.71	55.56	61.752	0.000	0.533	1.000
<i>HBP</i>	68.24	68.78	69.34	69.73	69.21	69.18	68.27	112.294	0.000	0.547	1.000

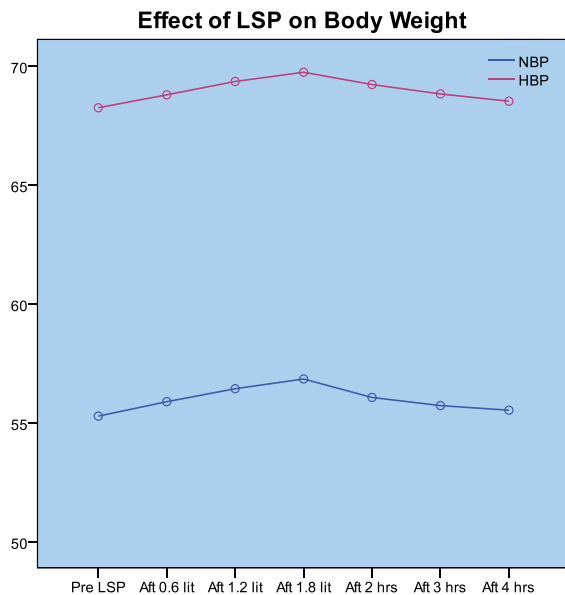
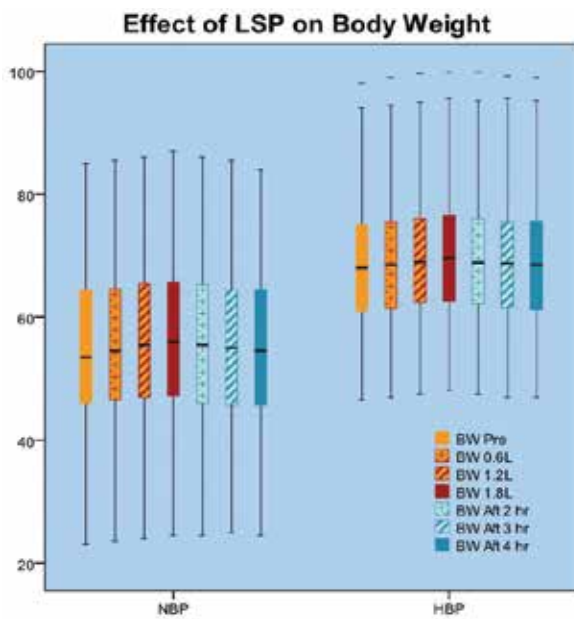
Table 9: Significance of differences in effects of LSP in normotensive and hypertensive subjects

Parameter	F	Significance	Remark
<i>Pulse-rate</i>	0.062	0.980	No difference between NBP & HBP groups
<i>Systolic BP</i>	2.646	0.049	Post LSP rise in SBP is similar but delayed fall is more in HBP group – significant
<i>Diastolic BP</i>	5.434	0.001	Post LSP rise in DBP is less and delayed fall is more in HBP group – highly significant
<i>Body weight</i>	1.554	0.158	No significant difference between NBP & HBP groups







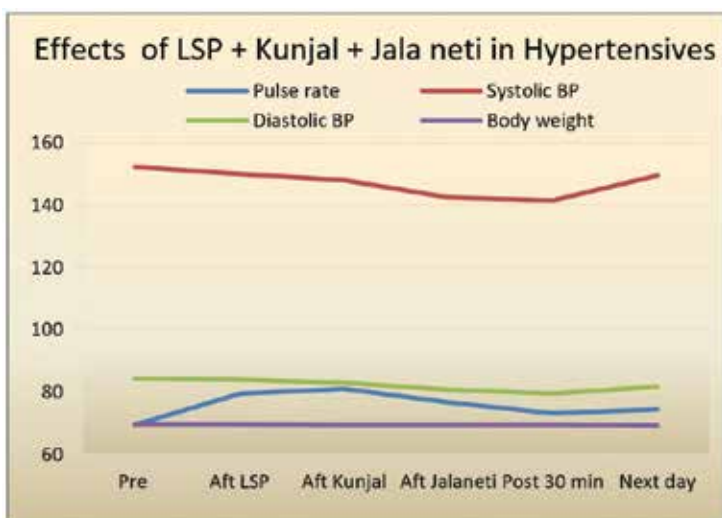
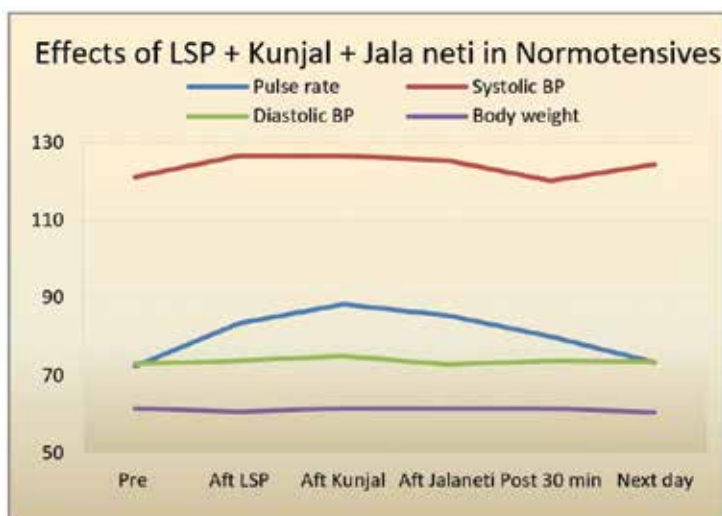


Study 2C

In 2006, subjects in the Asthma and Diabetes Projects conducted at the Yoga Research Centre run by Kasturba Hospital, BHEL, in Bhopal, India in collaboration with the Bihar School of Yoga, the combined effects of sequential practices of LSP, kunjaj and jala neti on the cardiovascular system and water retention was studied. Of the 28 patients, 10 were hypertensives and 18 had normal BP. There was a rise in pulse-rate after LSP and kunjaj, with a tendency to settle down after neti. In people with normal BP, the systolic and the diastolic BP increased marginally after LSP but decreased after neti. In the hypertensive group, the systolic and diastolic BP decreased to a small degree after each of the three practices. Body weight remained constant all through in both groups, showing no water retention. See Table 10 and the accompanying graphs.

Table 10: Effect of LSP + kunjaj + jala neti on cardiovascular system and water retention

	Pre	Aft LSP	Aft kunjaj	Aft jala neti	Post 30 min	Next day
Normotensives n=18						
<i>Pulse-rate</i>	72.39	83.44	88.29	85.50	79.89	73.25
<i>SBP</i>	121.17	126.69	126.47	125.28	120.06	124.38
<i>DBP</i>	72.89	73.69	75.00	72.78	73.72	73.56
<i>Body wt</i>	61.39	60.72	61.45	61.44	61.33	60.38
Hypertensives n=10						
<i>Pulse-rate</i>	69.40	79.57	81.00	76.60	73.20	74.50
<i>SBP</i>	152.30	149.86	148.00	142.40	141.50	149.50
<i>DBP</i>	84.20	84.00	83.00	80.80	79.60	81.70
<i>Body wt</i>	69.70	69.64	69.50	69.45	69.50	69.35



Physiological Effects of Laghoo Shankhaprakshalana (LSP) with Normal Saline Versus Water without Salt in Hypertensives and/or Diabetics, 2003

Summary

In 20 hypertensive subjects the effects of laghoo shankhaprakshalana (LSP) with salt and without salt were compared. The rise in pulse-rate and SBP, fall in DBP four hours post, and persistent weight gain were more in LSP with salt. LSP with saline was more effective in evacuating the bowels.

Study 3

In 20 hypertensive or diabetic subjects in health management courses at the Bihar School of Yoga in 2003, the comparative effects of LSP with normal saline and with salt-less water on the cardiovascular system, water retention measured as gain in body weight, time of first evacuation, and the pattern of swara were studied for up to four hours after the practice. The group consisted of 10 hypertensive persons, 1 hypertensive with hypothyroid, 5 diabetics with hypertension and 4 diabetic subjects. Each subject was subjected to both types of salt content at an interval of one week.

The rise in pulse-rate and systolic BP was more when LSP was done with saline water. The rise in diastolic BP was similar at both times but with saline water it dropped more after the practice and continued to fall for four hours, the duration of study. The weight gain was marginally more persistent in the salt group. The changes in pulse-rate and SBP were not significantly different in two groups but the delayed fall in DBP (0.034) and weight gain (0.002) was

statistically significantly more in the ‘with salt’ group. This difference is **not clinically significant**. See Tables 11 and 12 and the accompanying graphs.

Table 12: Significance of differences in effects of LSP with and without salt

Parameter	F	Signi- fiance	Remark
Pulse-rate	1.432	0.203	No significant difference between ‘with salt’ & ‘without salt’ groups
Systolic BP	0.466	0.833	No difference between ‘with salt’ & ‘without salt’ groups
Diastolic BP	4.818	0.034	Post LSP fall in DBP is more in ‘with salt’ group – Significant
Body weight	3.632	0.002	Greater and more persistent weight gain in ‘with salt’ group – Highly significant

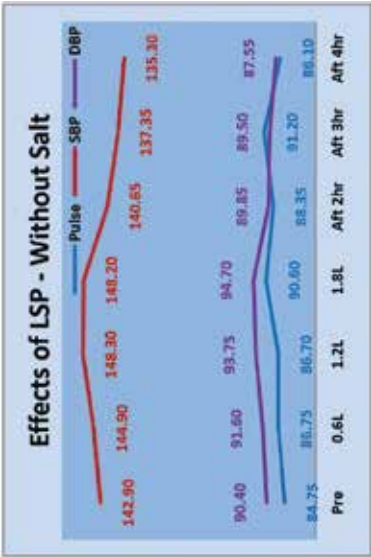
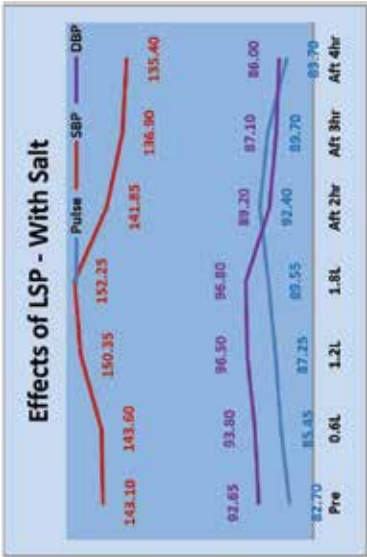
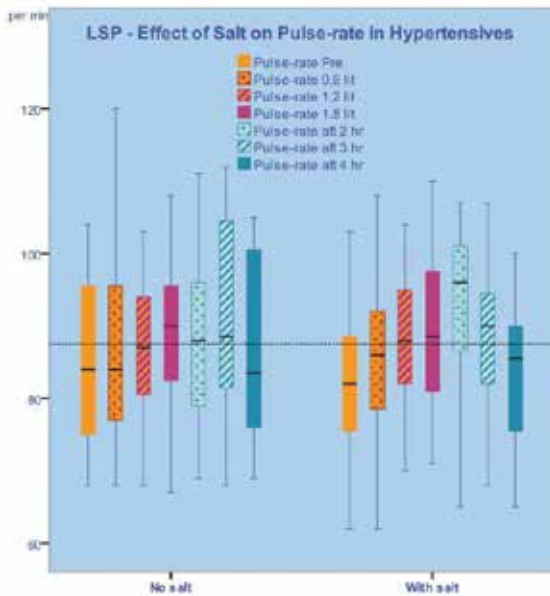
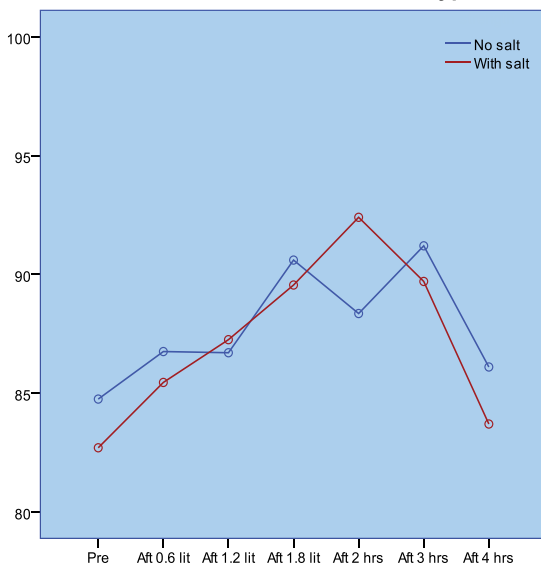


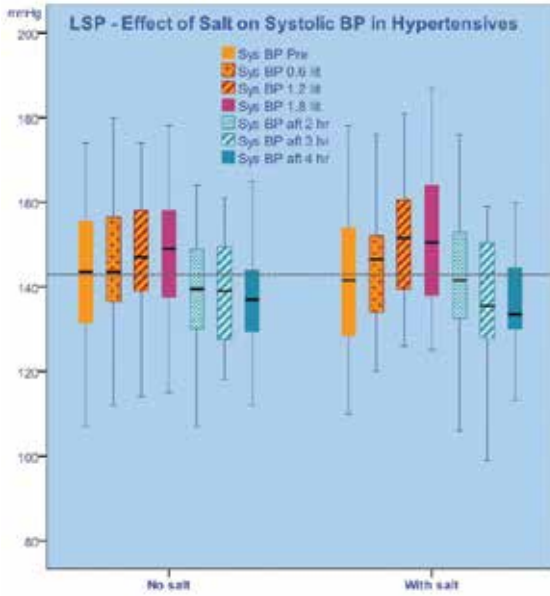
Table 11: Physiological effects of LSP with and without salt

n=20+20		Pre	0.6l	1.2l	1.8l	Aft 2hr	Aft 3hr	Aft 4hr
<i>Pulse</i>	<i>With salt</i>	82.70	85.45	87.25	89.55	92.40	89.70	83.70
	<i>Without salt</i>	84.75	86.75	86.70	90.60	88.35	91.20	86.10
<i>SBP</i>	<i>With salt</i>	143.10	143.60	150.35	152.25	141.85	136.90	135.40
	<i>Without salt</i>	142.90	144.90	148.30	148.20	140.65	137.35	135.30
<i>DBP</i>	<i>With salt</i>	92.65	93.80	96.50	96.80	89.20	87.10	86.00
	<i>Without salt</i>	90.40	91.60	93.75	94.70	89.85	89.50	87.55
<i>Weight</i>	<i>With salt</i>	70.83	71.45	72.05	72.51	72.63	72.22	71.54
	<i>Without salt</i>	70.69	71.46	72.03	72.30	72.07	71.69	71.24

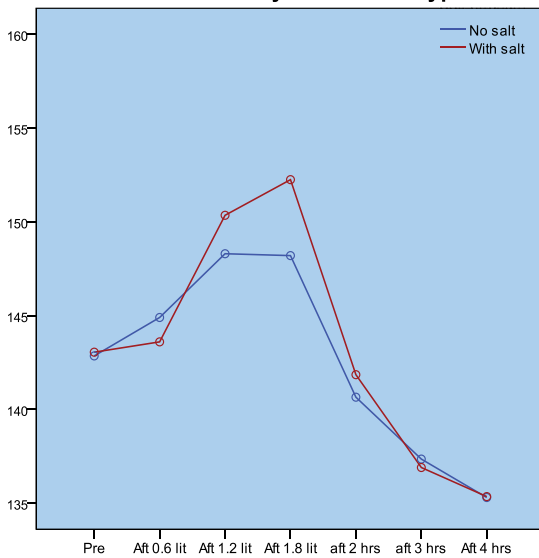


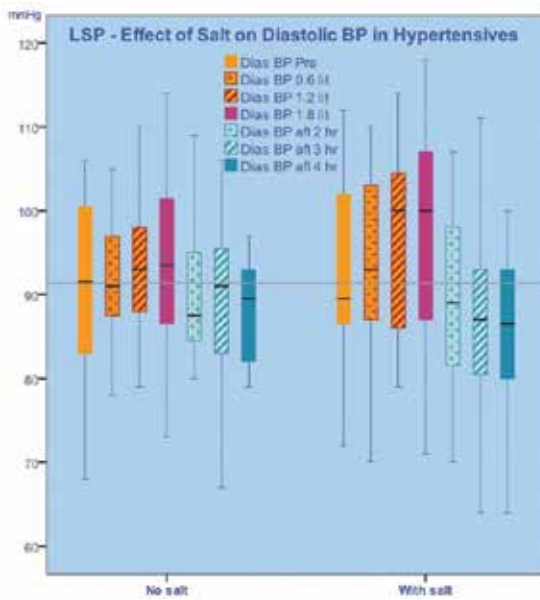
LSP - Effect of Salt on Pulse-rate in Hypertensives



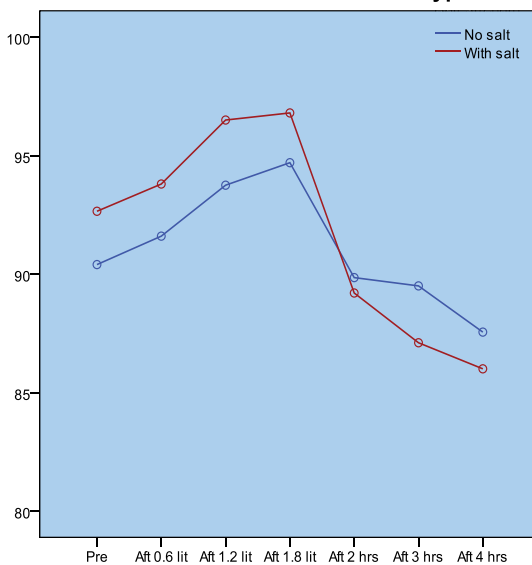


LSP - Effect of Salt on Systolic BP in Hypertensives

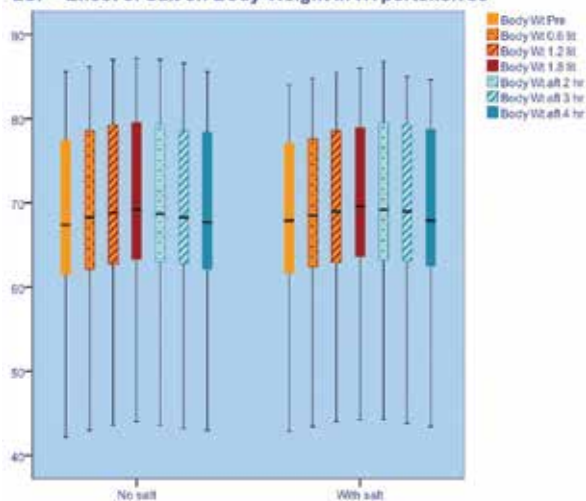




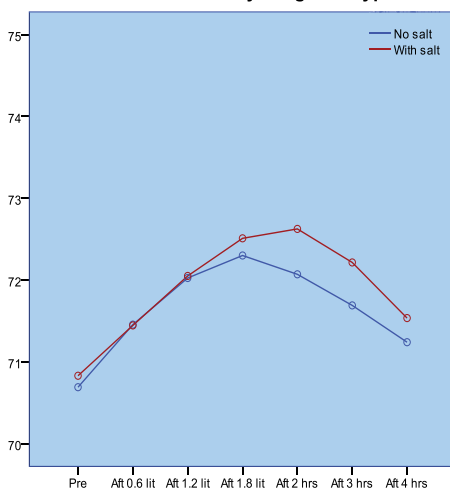
LSP - Effect of Salt on Diastolic BP in Hypertensives



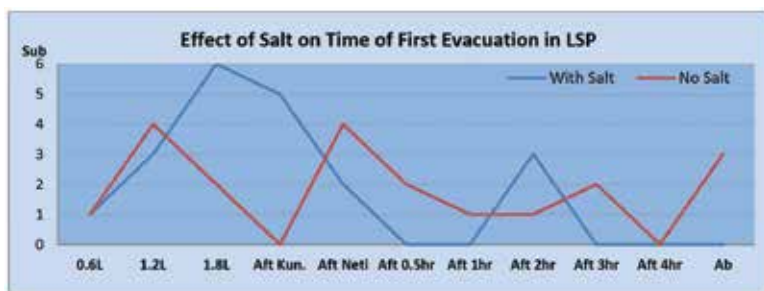
LSP - Effect of Salt on Body-Weight in Hypertensives



LSP - Effect of Salt on Body Weight in Hypertensives



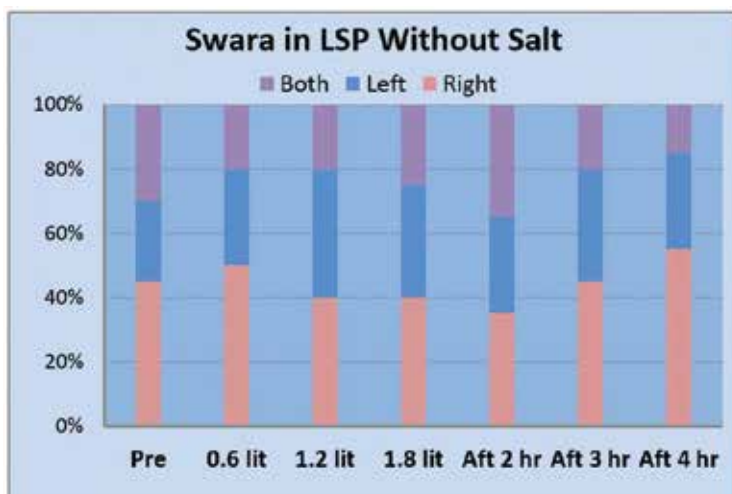
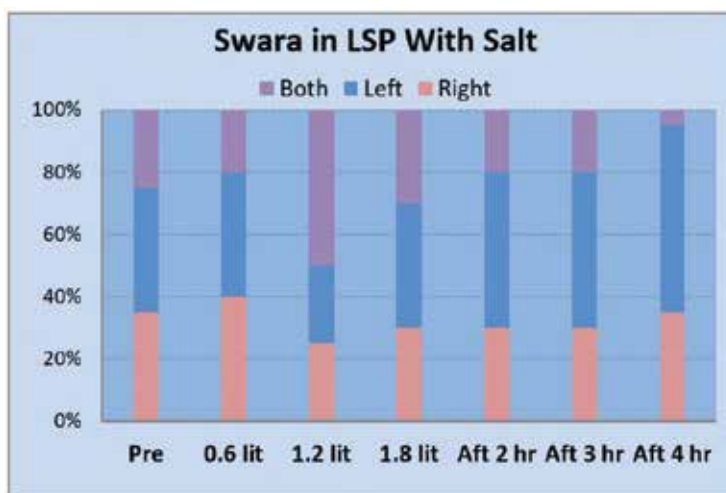
The practice was more effective when done with saline water as indicated by time of first evacuation. 17 subjects out of 20 had their first evacuation by the time they did neti when done with saline but only 11 subjects in case of salt free water. 3 subjects in that group could not evacuate at all.



LSP with salt had initial pingala stimulation but towards the end of practice, sushumna or the balanced swara became dominant. All through the study time of four hours post, ida preponderance was observed. The state of sushumna and ida dominance points towards balanced, contented, introverted and relaxed states of mind respectively. LSP without salt showed early pingala dominance followed by ida dominance that continued only until 2 hours post, later again pingala became active denoting discomfort and extroversion due to inadequate emptying of bowels. Pingala corresponds to sympathetic activity, ida to parasympathetic and sushumna to balanced state of autonomic nervous system.

Table 13: Pattern of swara in LSP with salt and without salt

With salt							
n=20	Pre	0.6l	1.2l	1.8l	Aft 2 hr	Aft 3 hr	Aft 4 hr
Right	7	8	5	6	6	6	7
Left	8	8	5	8	10	10	12
Both	5	4	10	6	4	4	1
Without salt							
n=20	Pre	0.6l	1.2l	1.8l	Aft 2 hr	Aft 3 hr	Aft 4 hr
Right	9	10	8	8	7	9	11
Left	5	6	8	7	6	7	6
Both	6	4	4	5	7	4	3



Psychophysiological Effects of 9-day Serial Laghoo Shankhaprakshalana (LSP), 2001

Summary

In 32 students of Bihar Yoga Bharati the effects of 9-day serial LSP were observed. The physiological parameters of pulse-rate, SBP and DBP and body weight (water retention) remained steady over 9 days but daily after the practice there was a temporary rise in each of the parameters. PEFr showed small but consistent improvement after the practice and over the 9 days. The swara showed tendency towards balanced swara or left swara. There was no change in psychological parameters. The flexibility improved over the period.

Study 4

Thirty-two young, healthy students of one-year diploma and two-year post-graduate (PG) classes in Bihar Yoga Bharati practised consecutive nine days of LSP as their Navaratri Sadhana in October 2001. They were observed for changes in pulse-rate, systolic as well as diastolic BP, water retention measured as gain in body weight, PEFr and pattern of swara. The data was collected before the practice at 5 am, just after the practice at about 5.30 to 5.50 am and in the evening at 5 pm daily for the nine days. They were also observed for the psychological effects of LSP on eight dimensions: happy mood, energy level, peacefulness, alertness, concentration, extro-intro-version, quality of thoughts and anxiety-security. These parameters were scored by the participants on a scale of 5 by self-assessment for the nine days of practice. Eighteen two-year PG students were also observed for flexibility of the body a day prior and a day after the 9-day study using five asanas: hastapadasana,

dhanurasana, trikonasana variation 3, hanumanasana and gomukhasana.

In the young healthy subjects all the three parameters of the cardiovascular system remained steady and within normal physiological range during pre, post and evening time throughout the nine days. The post values of pulse-rate, BP and body weight were always higher than pre values and the ‘pm’ values were lower than the post values, nearing the pre values. All the three values ran parallel to each other in each parameter. The PEFR showed marginal but consistent improvement after the practice and little more substantial but less consistent improvement in the evenings. See Table 16 and the accompanying graphs. The swara always showed inclination towards left and/or two-nostril dominance after the practice. See Table 17 and the accompanying graph.

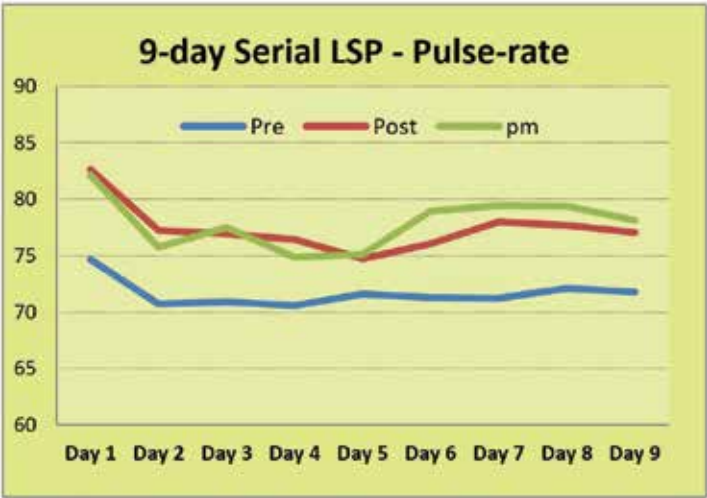


Table 16: Physiological effects of 9-day serial LSP in young healthy subjects

n=32	Pulse-rate			Systolic BP			Diastolic BP			Body weight			PEFR		
	Pre	Post	pm	Pre	Post	pm	Pre	Post	pm	Pre	Post	pm	Pre	Post	pm
Day 1	74.66	82.66	82.16	113.81	117.13	113.56	76.00	78.47	74.31	50.62	51.89	51.02	476	488	485
Day 2	70.72	77.28	75.75	111.38	116.19	115.34	74.47	77.81	74.34	50.81	52.21	51.28	468	486	486
Day 3	70.91	76.94	77.53	113.97	116.16	112.87	75.13	76.66	73.00	50.58	51.93	50.98	473	482	493
Day 4	70.56	76.42	74.84	115.88	118.41	113.13	76.28	78.72	75.06	50.47	51.94	51.03	473	471	474
Day 5	71.63	74.75	75.13	112.90	115.74	114.60	76.39	77.81	73.04	50.40	52.08	51.06	475	484	500
Day 6	71.28	76.06	78.94	112.84	115.66	115.83	74.47	77.25	75.07	50.41	51.93	51.28	475	478	495
Day 7	71.23	78.03	79.43	113.20	116.80	114.72	74.37	78.40	76.66	50.50	52.02	51.23	473	479	474
Day 8	72.10	77.71	79.37	115.10	115.83	115.11	76.86	78.76	77.56	50.34	51.86	50.74	461	482	488
Day 9	71.80	77.07	78.11	113.63	114.97	115.96	77.43	77.24	76.70	50.16	51.65	50.93	469	479	507

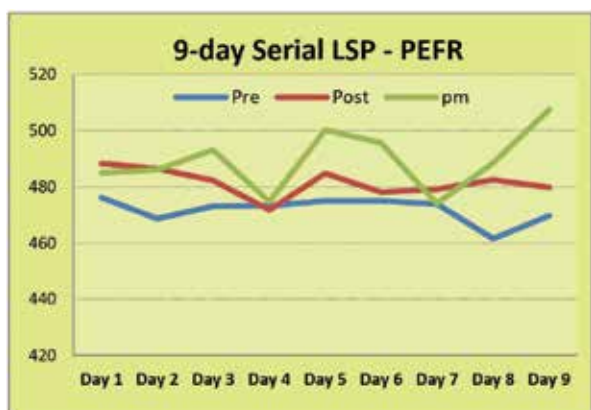
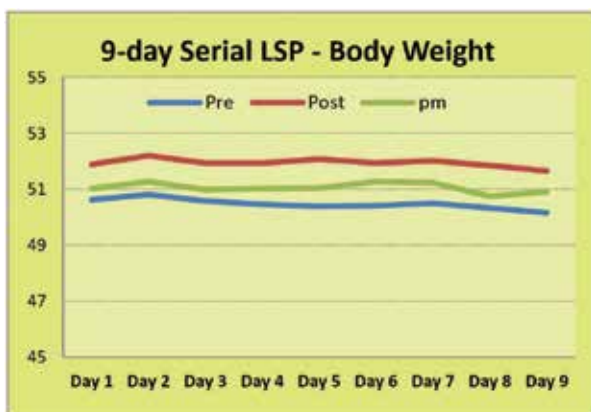
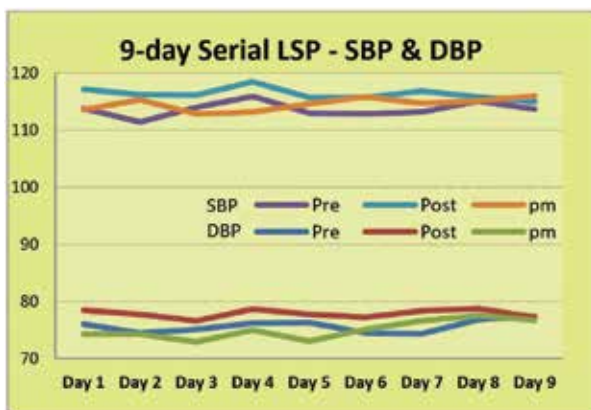
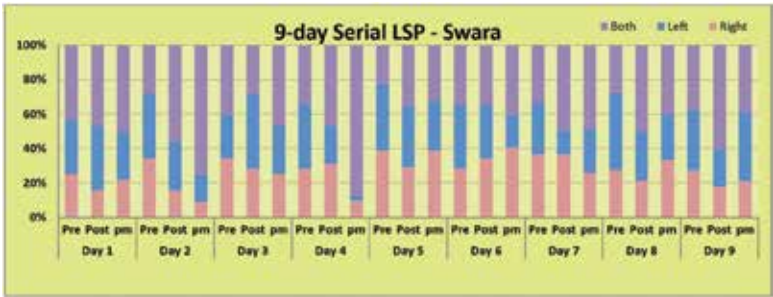


Table 17: Pattern of swara in 9-day serial LSP

	Pre	Post	pm	Pre	Post	pm	Pre	Post	pm
n=32	Day 1			Day 2			Day 3		
Right	8	5	7	11	5	3	11	9	8
Left	10	12	9	12	9	5	8	14	9
Both	14	15	16	9	18	24	13	9	15
	Day 4			Day 5			Day 6		
Right	9	10	13	12	9	12	9	11	13
Left	12	7	4	12	11	9	12	10	6
Both	11	15	115	7	11	10	11	11	13
	Day 7			Day 8			Day 9		
Right	11	11	8	8	6	10	8	5	6
Left	9	4	8	13	8	8	10	6	11
Both	10	15	15	8	14	12	11	17	11

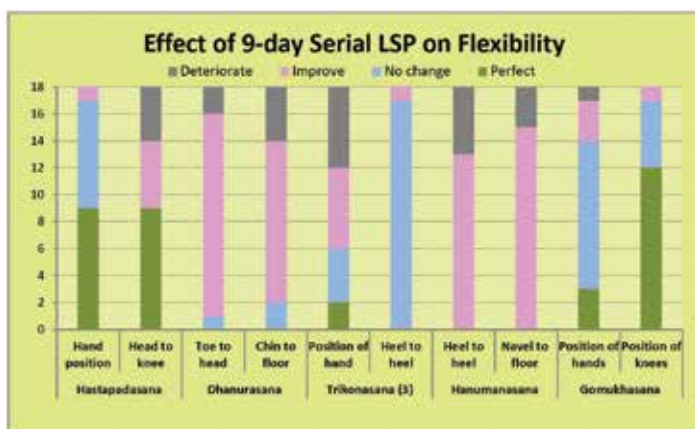


Six asanas were chosen initially to measure flexibility of spine and hip covering all the movements of spine and forward, backward and inward movements of hip. Gatyatmak meru wakrasana was dropped from the calculation as there was a technical flaw in the measurement procedure. There was great improvement in the range of movement within the short span of nine days and without practising those asanas. Table 28 shows the number of subjects showing changes in

flexibility. Dhanurasana showing backward bending ability of the spine and hanumanasana showing forward-backward movement of hip joints showed maximum improvement. Hastapadasana showing forward bending ability of spine also showed good improvement. See Table 18 and the accompanying graph.

Table 18: Effects of 9-day serial LSP on flexibility in young healthy subjects

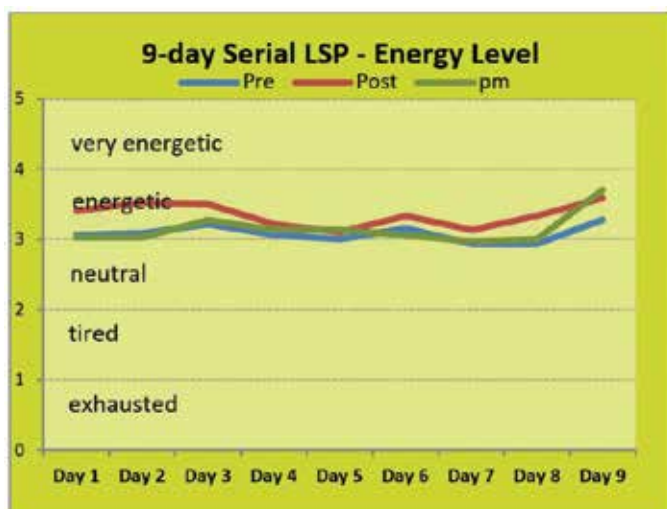
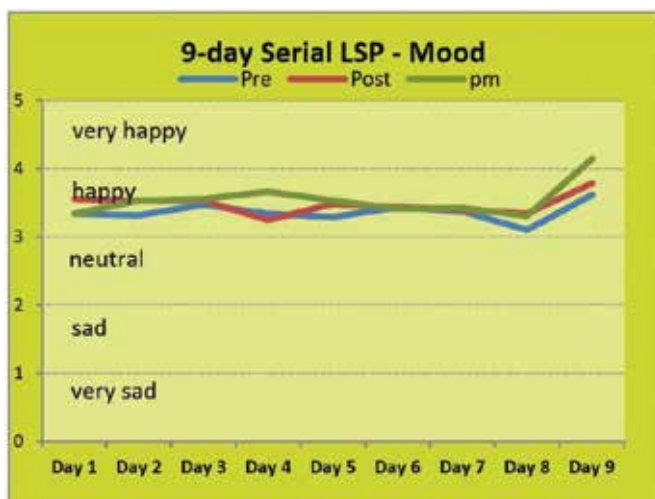
	Hastapadasana		Dhanurasana	
n=18	<i>Hand position</i>	<i>Head to knee</i>	<i>Toe to head</i>	<i>Chin to floor</i>
<i>Perfect</i>	9	9	0	0
<i>No change</i>	8	0	1	2
<i>Improve</i>	1	5	15	12
<i>Deteriorate</i>	0	4	2	4
	Trikonasana (3)		Hanumanasana	
	<i>Position of hand</i>	<i>Heel to heel</i>	<i>Heel to heel</i>	<i>Navel to floor</i>
<i>Perfect</i>	2	0	0	0
<i>No change</i>	4	17	0	0
<i>Improve</i>	6	1	13	15
<i>Deteriorate</i>	6	0	5	3
	Gomukhasana			
	<i>Position of hands</i>	<i>Position of knees</i>		
<i>Perfect</i>	3	12		
<i>No change</i>	11	5		
<i>Improve</i>	3	1		
<i>Deteriorate</i>	1	0		

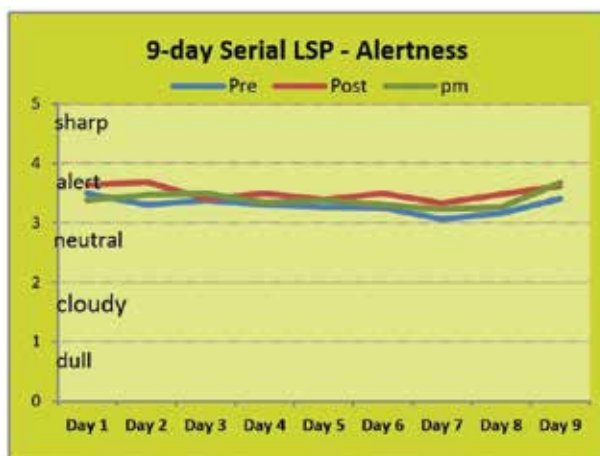
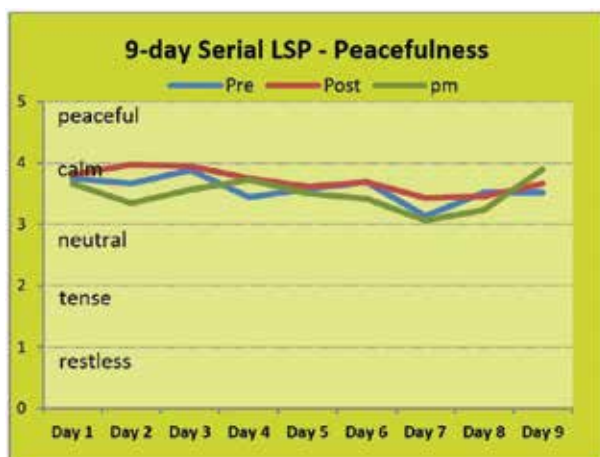


Mood did not show any particular trend. Energy level and alertness improved significantly every day after the practice but was not sustained throughout the day. The subjects felt more peaceful just after the practice but reverted back to 'pre' level during the day.

Table 19: Psychological effects of 9-day serial LSP in young healthy subjects

n=32	Mood			Energy			Peacefulness			Alertness		
	Pre	Post	pm	Pre	Post	pm	Pre	Post	pm	Pre	Post	pm
Day 1	3.34	3.56	3.34	3.06	3.41	3.03	3.75	3.81	3.66	3.50	3.63	3.38
Day 2	3.31	3.53	3.53	3.09	3.53	3.03	3.66	3.97	3.34	3.31	3.69	3.47
Day 3	3.47	3.53	3.56	3.22	3.50	3.28	3.88	3.94	3.56	3.38	3.41	3.50
Day 4	3.34	3.25	3.66	3.06	3.22	3.13	3.44	3.75	3.72	3.31	3.50	3.34
Day 5	3.29	3.48	3.53	3.00	3.10	3.13	3.58	3.61	3.50	3.26	3.39	3.38
Day 6	3.44	3.44	3.41	3.16	3.34	3.06	3.69	3.69	3.42	3.25	3.50	3.31
Day 7	3.37	3.40	3.42	2.93	3.13	2.97	3.13	3.43	3.06	3.07	3.33	3.23
Day 8	3.10	3.34	3.30	2.93	3.34	3.00	3.52	3.45	3.23	3.17	3.48	3.27
Day 9	3.62	3.79	4.14	3.28	3.59	3.70	3.52	3.66	3.90	3.41	3.62	3.67



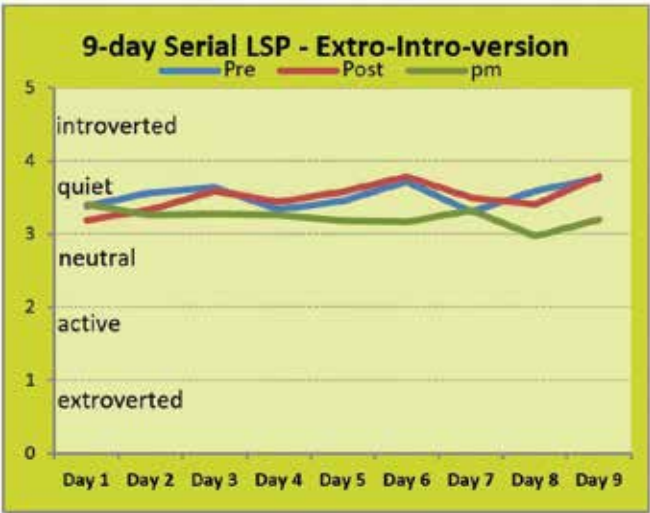
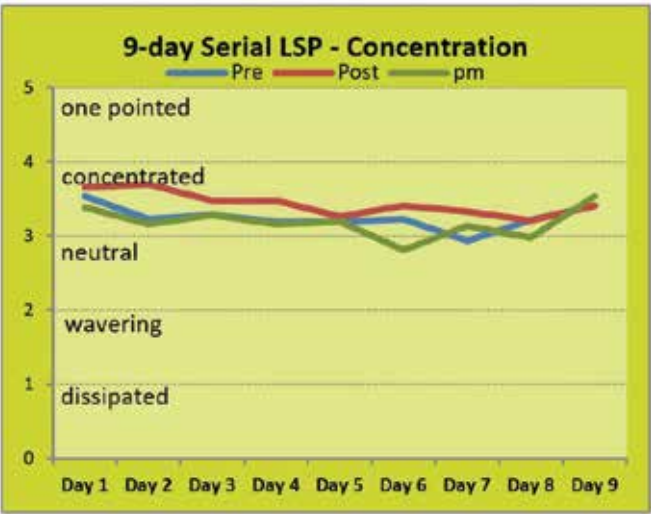


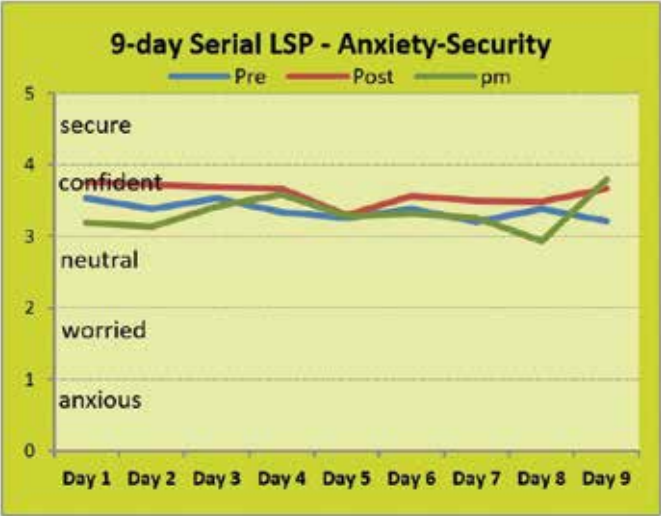
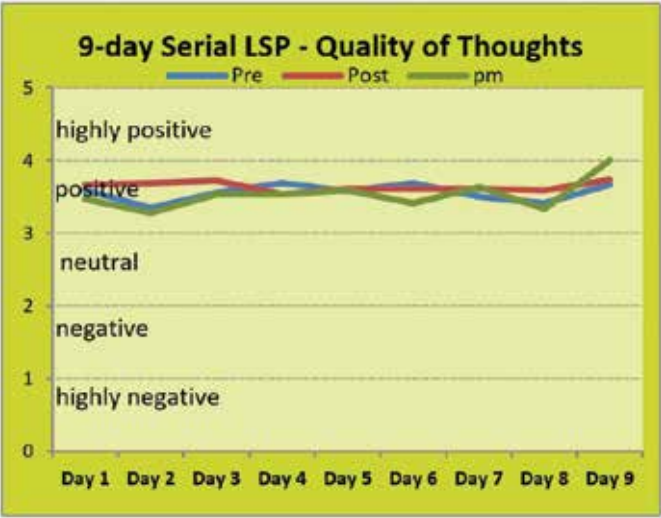
Concentration ability improved just after the practice but during the day it was similar to 'pre' level. The immediate effect of the practice was mildly introverting but the overall effect during the day was quite extroverting. The quality of thoughts remained more or less unchanged. The subjects felt more confident and secure just after the practice but that feeling was not carried forward through the day.

None of the eight psychological parameters showed any particular trend over the nine-day period.

Table 20: Psychological effects of 9-day serial LSP in young healthy subjects

	Concentration			Extro-introversion			Quality of thoughts			Anxiety-security		
	Pre	Post	pm	Pre	Post	pm	Pre	Post	pm	Pre	Post	pm
n=32												
Day 1	3.53	3.66	3.38	3.38	3.19	3.41	3.59	3.66	3.47	3.53	3.75	3.19
Day 2	3.22	3.69	3.16	3.56	3.34	3.25	3.34	3.69	3.28	3.38	3.72	3.13
Day 3	3.28	3.47	3.28	3.63	3.59	3.28	3.56	3.72	3.53	3.53	3.69	3.41
Day 4	3.19	3.47	3.16	3.34	3.44	3.25	3.69	3.53	3.53	3.34	3.66	3.59
Day 5	3.19	3.26	3.19	3.45	3.58	3.19	3.58	3.61	3.59	3.26	3.29	3.28
Day 6	3.22	3.41	2.81	3.72	3.78	3.16	3.69	3.61	3.41	3.38	3.56	3.31
Day 7	2.93	3.33	3.13	3.30	3.50	3.32	3.50	3.61	3.63	3.20	3.50	3.26
Day 8	3.21	3.21	2.97	3.59	3.41	2.97	3.41	3.59	3.33	3.38	3.48	2.93
Day 9	3.41	3.41	3.53	3.76	3.79	3.20	3.66	3.73	4.00	3.21	3.66	3.79





Physiological Effects of PSP with 27 Days of Serial Laghoo Shankha-prakshalana (LSP) in Diabetics, 2002

Summary

In 15 diabetic subjects in a 42-day Intensive Diabetic Course, 27 days of consecutive LSP including one PSP showed rise in systolic as well as diastolic BP in 9 subjects including 5 hypertensives. The BP started rising as early as the third day of the practice and continued to rise until the last day.

Study 5

Combined effects of serial LSP (27 days) with one PSP on BP: Morning BP and body weight were checked on every Sunday for 15 diabetics of an intensive 42-day Health Management Research Course. Apart from other yoga practices they started serial LSP on day 5 and continued until day 32. On day 8 they did PSP and day 9 was rest day. They ate normal diet except during the restricted period of PSP. Five of the subjects had hypertension, four were taking medication and one was not. **Nine of the 15 subjects including all the five with hypertension showed substantial rise in systolic as well as diastolic BP as early as 3 days of LSP (day 7).** The other 6 subjects tolerated the practices without detrimental effects on BP. We present here the data of the whole group of 15 subjects in Table 20 and also **of these 9 subjects only** in Table 20a to emphasize the effects of frequent LSP especially on people with marginalized physiology. It is difficult to predict who will respond well and who will have detrimental effects. There was no gain in body weight but in fact there was overall loss. See Tables 21, 21a and the accompanying line graphs. The changes were highly significant for all the three parameters for the whole group of 15 subjects. See Table 21b. The box plots represent the percentile data of all the 15 subjects.

Table 21: Effect of long-term serial LSP on BP in diabetic subjects

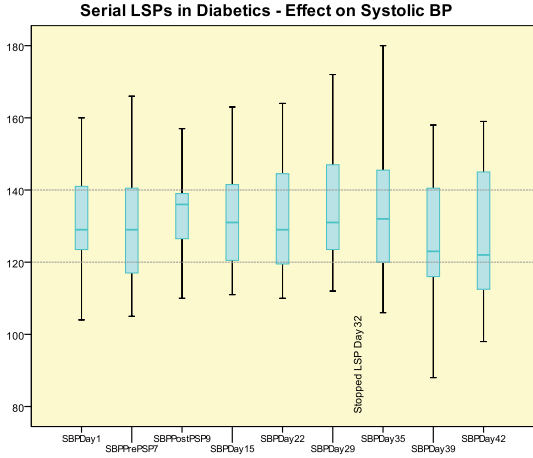
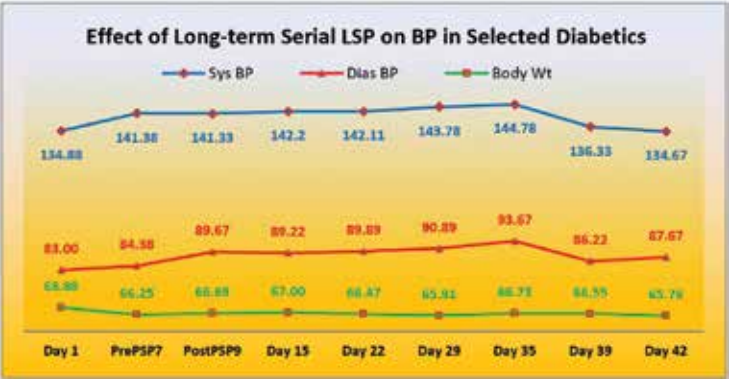
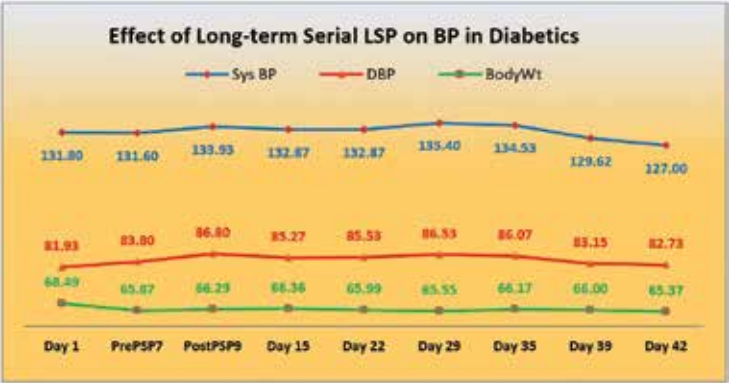
n=15	Day 1	PrePSP7	PostPSP9	Day 15	Day 22	Day 29	Day 35	Day 39	Day 42
<i>Sys BP</i>	131.80	131.60	133.93	132.87	132.87	135.40	134.53	129.62	127.00
<i>Dias BP</i>	81.93	83.13	81.00	85.27	85.53	86.53	86.07	83.15	82.73
<i>Body wt</i>	68.49	65.87	66.29	66.36	65.99	65.55	66.17	66.00	65.37

Table 21a: Effect of long-term serial LSP on BP in selected diabetic subjects

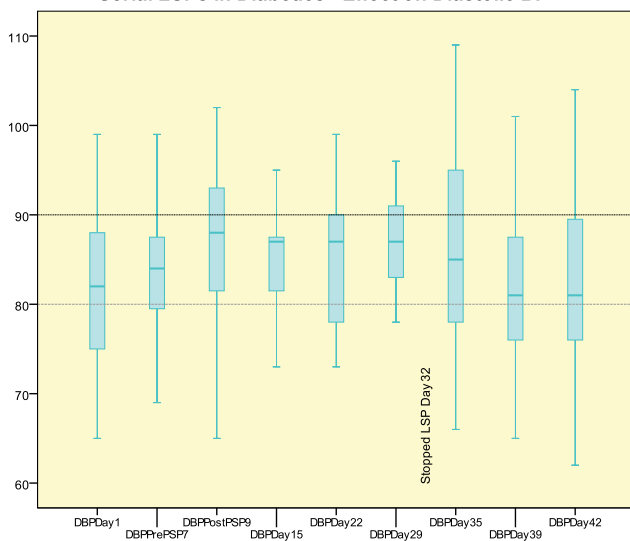
n=9	Day 1	PrePSP7	PostPSP9	Day 15	Day 22	Day 29	Day 35	Day 39	Day 42
<i>Sys BP</i>	134.88	141.38	141.33	142.2	142.11	143.78	144.78	136.33	134.67
<i>Dias BP</i>	83.00	84.38	89.67	89.22	89.89	90.89	93.67	86.22	87.67
<i>Body wt</i>	68.88	66.25	66.69	67.00	66.47	65.91	66.73	66.55	65.76

Table 21b: Statistical significance of effects of long-term serial LSP on BP in diabetic subjects

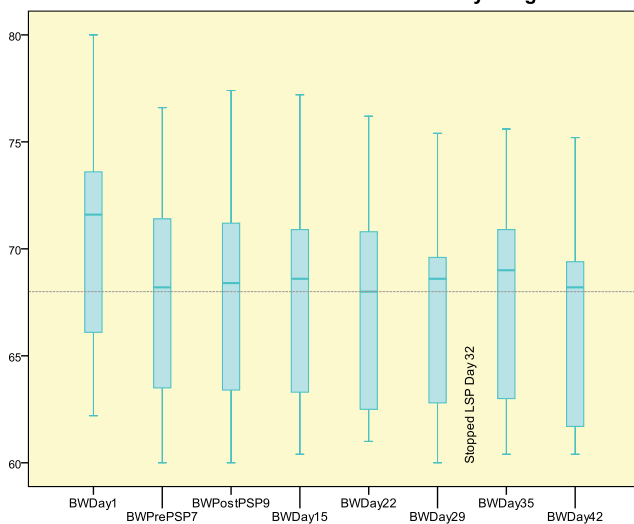
n=15	F	Significance	Partial eta squared	Observed power
<i>Sys BP</i>	97.55	0.000	0.993	1.000
<i>Dias BP</i>	124.847	0.000	0.995	1.000
<i>Body wt</i>	91.802	0.000	0.991	1.000



Serial LSPs in Diabetics - Effect on Diastolic BP



Serial LSPs in Diabetics - Effect on Body Weight



Discussion and summary

In healthy subjects the pulse-rate and systolic and diastolic BP increase during LSP practice due to physical exertion but immediately they decrease as the physical activity stop and continue to decrease for the next 2–3 hours as the bowel movements are stimulated and parasympathetic becomes active. This finding is supported by the findings of the swara pattern. There is no or minimal water absorption into the circulatory system and no weight gain. Bowel evacuation starts after 4–6 glasses of water in the majority of the subjects and is complete in less than 2 hours. There was no substantial effect on PEFR.

In the non-hypertensive patient population the findings were similar but the fluctuations in pulse and BP were of bigger amplitude and longer lasting though within normal physiological range. They took much longer to normalize their body weight indicating larger quantity of water absorption into the circulatory system. In asthmatic subjects PEFR marginally decreased during the practice probably due to distension of abdomen but normalized to pre level by 2 hours post practice.

Unexpectedly, but fortunately, the hypertensive patient population showed lesser fluctuations in mean values of pulse-rate and BP than their non-hypertensive counterparts. On further analysis it was observed that (see the note below) many subjects showed big amplitudes of rise in pulse-rate and systolic and diastolic BP during the actual practice. There was almost equal number of subjects showing decrease in all the three parameters during the practice. **This gave a wrong picture of stable BP.** Fortunately **during the rest time after the practice the values came down** and even went below 'pre' levels. **This may lead to a false sense of safety amongst the practitioners.** It is hard to predict which person will behave how during the practice. **High BP for a short time can also, at times, lead to serious consequences.** People with well-controlled hypertension may be allowed LSP under caution and vigilance of a teacher but the frequency of LSP must be adjusted with BP monitoring on regular on-going basis.

Note: 60 out of 94 subjects showed rise in pulse-rate by 10 or more beats per minute (bpm), maximum up to 46 bpm, while 12 subjects showed fall by 10 bpm or more, maximum up to 24 bpm. The fall in pulse-rate was mainly after the practice during rest time. 56 out of 94 subjects showed rise in systolic BP by 10mmHg or more, maximum up to 51mmHg. 59 subjects showed fall in SBP by 10mmHg or more, maximum up to 40mmHg. 34 out of 94 subjects showed rise in diastolic BP of 10mmHg or more, maximum up to 30mmHg. 44 subjects showed fall in DBP by 10mmHg or more, maximum up to 31mmHg. The rise in SBP and DBP was mainly during the practice while the fall was mainly after the practice during rest time.

LSP done with plain water (without salt) is less effective. In hypertensive subjects the effects of LSP with or without salt on pulse and BP are similar. Similarly, in diabetic subjects no difference was found on the net effect on pulse-rate and BP when LSP was done singly or followed by kunjal and neti.

In young healthy subjects, pulse-rate, BP and body weight remained stable when LSP was done for nine consecutive days. Their flexibility improved greatly in forward-backward movements of spine and hips. Of the eight psychological parameters studied during nine consecutive days of LSP, energy level, alertness, peacefulness, concentration and feeling of confidence and security improved after the practice but were not sustained through the day. The immediate effect of the practice was mildly introverting but the overall effect during the day was quite extroverting. Mood and the quality of thoughts remained more or less unchanged. None of the eight parameters exhibited any particular trend over the nine-day period.

In 4 out of 10 diabetic plus all 5 diabetic subjects with hypertension, consecutive LSP over 27 days showed substantial rise in systolic as well as diastolic BP as early as after 3 days that continued to rise over the study period. There was no gain in weight due to LSP but in fact there was weight loss due to regular hatha yoga practices and a rigorous lifestyle.

Physiological Effects and Hydrodynamics of Poorna Shankhaprakshalana (PSP), 2000–2002

Introduction

In the classical version of shankhaprakshalana, according to yogic scriptures, a large quantity of warm water is drunk followed by rigorous practice of nauli, another shatkarma of hatha yoga, also known as loliki. In the practice of nauli the muscles of anterior abdominal wall are contracted and relaxed in a particular sequence. This massages the abdominal organs and pushes the water in stomach down through intestine and colon and expels it out. In Satyananda Yoga the practice has been adapted to suit the limitations of modern practitioners. Two glasses of warm saline water are drunk and five asanas (tadasana, tiryak tadasana, kati chakrasana, tiryak bhujangasana and udarakarshanasana) are performed eight times each. Again and again the warm saline water is drunk and the asanas repeated until the bowels are expelling almost clear water without any solid contents. Generally it takes 12–18 glasses of water and that many rounds of asanas. It is followed by kunjla kriya and neti. The practitioner then rests for 45 minutes and has a special meal. There are dietary, water intake and activity restrictions/guidelines for 48 hours.

Its physiological and pranic effects are like laghoo shankhaprakshalana but in greater magnitude (see page 28).

Yoga Research Foundation, Munger, Bihar, conducted two studies to investigate the water dynamics and observe some of the physiological effects of PSP in healthy subjects as well as in diabetic subjects.

Summary

The practice of PSP causes initial rise in pulse-rate and BP but later a fall below pre level. The swara findings were in alignment too, initial pingala activity followed by ida predominance. About 66% of water intake remained in GI tract and was excreted and 19% of intake was absorbed and either was expelled via urine (8%) or showed up as weight gain (11%). Kunjal output accounted for about 15% of total water intake.

Study 1

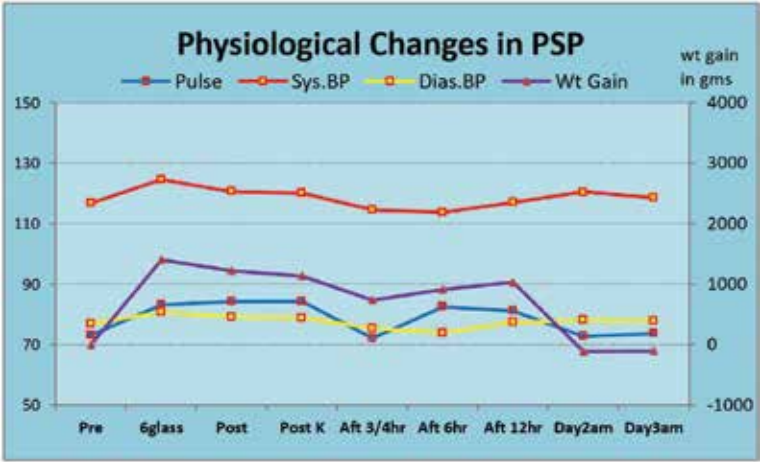
Thirty-eight young healthy post-graduate students of Bihar Yoga Bharati (2000 and 2002) and 12 diabetic subjects of an Intensive Health Management Research Course (2002) were observed for water intake and output, pulse-rate, BP, body weight and swara while doing the practice of PSP, and later for the next 48 hours. GI output was calculated by subtracting total urine output (urine and kunjal kriya) and weight gain from total water intake. It could be only a rough estimate as water loss from perspiration and through breath was not taken into account.

The pulse-rate, systolic and diastolic BP rose within the physiological range initially due to physical exertion but settled at the elevated level or decreased a little in spite of continued physical efforts due to parasympathetic effect of the practice as the GI tract movement started. The full effect of parasympathetic activity was seen at the rest period of 'after 3/4 of an hour'.

Table 1: Physiological effects of PSP

n=50	Pre	6 glass	Post	Post k	Aft 3/4hr
Pulse	73.20	83.16	84.20	84.28	72.14
Sys. BP	116.82	124.54	120.50	120.20	114.68
Dias. BP	77.00	80.66	79.10	78.86	75.36
Body wt	54.95	56.35	56.17	56.08	55.70

	Aft 6hr	Aft 12hr	Day 2 am	Day 3 am
Pulse	82.44	81.14	72.82	73.58
Sys. BP	113.74	117.10	120.46	118.54
Dias. BP	73.96	77.44	78.14	77.90
Body wt	55.88	55.98	54.83	54.83

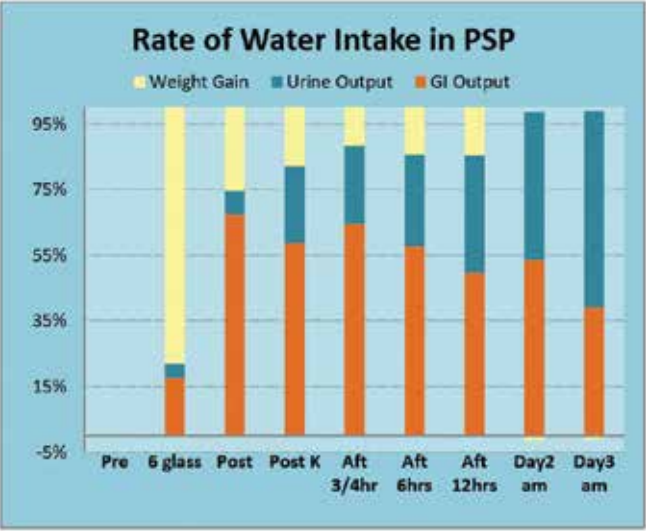
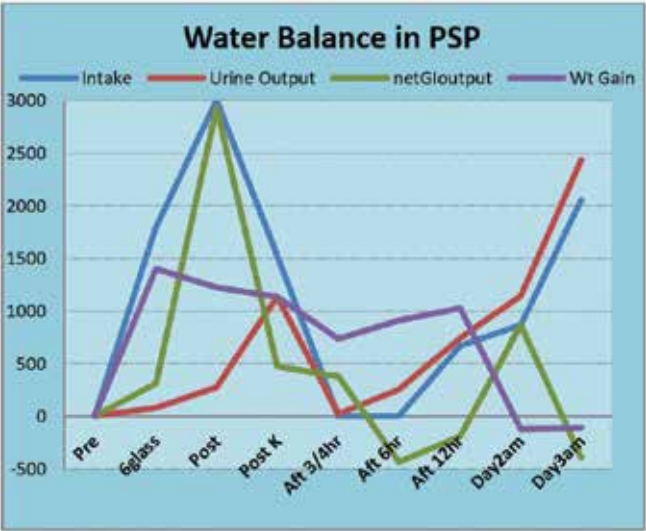


The study showed that PSP is very effective in cleansing GI tract. **About 66% of water intake stayed within the GI tract** and eventually was evacuated through the rectum. Kunjal output was 15% and urine 8% of the total intake at the end of 45 minutes rest period and only 11% of the water intake, about 700 ml, was still within the cardiovascular system. **Total**

absorption of water into the body systems was about 19% (11% retention + 8% urine output). It was fully cleared before 12 hours. Mean total intake during the practice was 6352 ml. Urine output between the periods ‘after 3/4 of an hour’ and ‘after 12 hours’ was 994 ml. This means that all the absorbed water is expelled out.

Table 2: Water dynamics in PSP

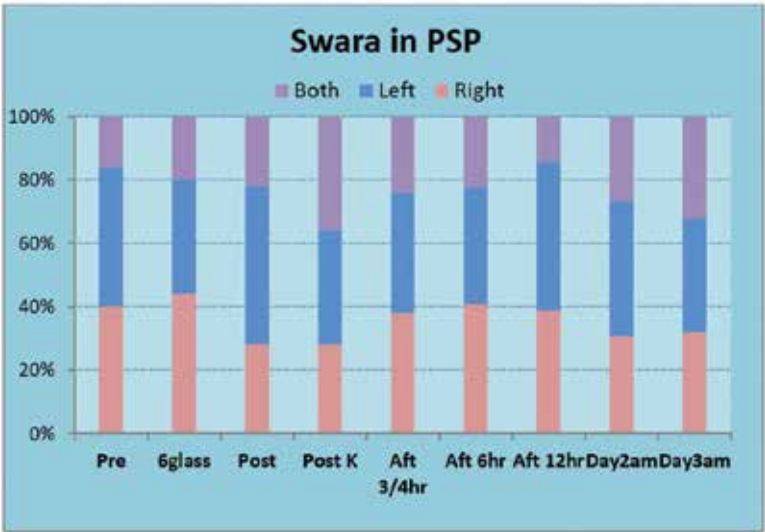
	in ml/gm				cumulative output/ cumulative intake %		
n=50	Intake	Urine+k output	Wt gain	GI output	U+k	Wt (gain/ in)	GI
<i>Pre</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>6 glass</i>	1800.00	81.20	1402.00	316.80	4.51	77.89	17.60
<i>Post</i>	3006.00	274.00	1224.00	2930.00	7.36	25.36	67.28
<i>Post K</i>	1530.00	1135.40	1138.00	476.60	23.47	17.92	58.62
<i>Aft 3/4hr</i>	0.00	23.10	736.00	378.90	23.83	11.59	64.58
<i>Aft 6hr</i>	0.00	253.50	914.00	-431.50	27.82	14.39	57.79
<i>Aft 12hr</i>	668.00	740.50	1030.00	-188.50	35.72	14.67	49.61
<i>Day 2 am</i>	864.00	1142.80	-118.00	869.20	46.30	-1.50	55.19
<i>Day 3 am</i>	2054.40	2437.90	-108.44	-393.06	61.26	-1.09	39.83



Swara showed an initial rise in pingala activity, but as the practice progressed ida activity started to dominate. Motility in GI tract (a function of parasympathetic system) leads to ida dominance or vice versa. After the rest time pingala and ida were balanced.

Table 3: Pattern of swara in PSP

n=50	Pre	6 glass	Post	Post k	Aft 3/4hr	Aft 6hr	Aft 12hr	Day 2 am	Day 3 am
<i>Right</i>	20	22	14	14	19	20	19	15	16
<i>Left</i>	22	18	25	18	19	18	23	21	18
<i>Both</i>	8	10	11	18	12	11	7	13	16



Physiological Effects of Poorna Shankhaprakshalana (PSP) with Normal Saline Versus Half-Strength Saline Water, 2002–2003

Summary

There is initial rise in pulse-rate (PR) and BP followed by fall in both groups but in the half strength saline group (group B) the fall in PR was more. The full strength saline group (group A) required less quantity of intake (4500 ml), only 15% intake got absorbed in circulation, and PSP result was satisfactory (63%). Group B required larger intake (5200 ml), 50% intake got absorbed in circulation, and PSP result was poor (35%).

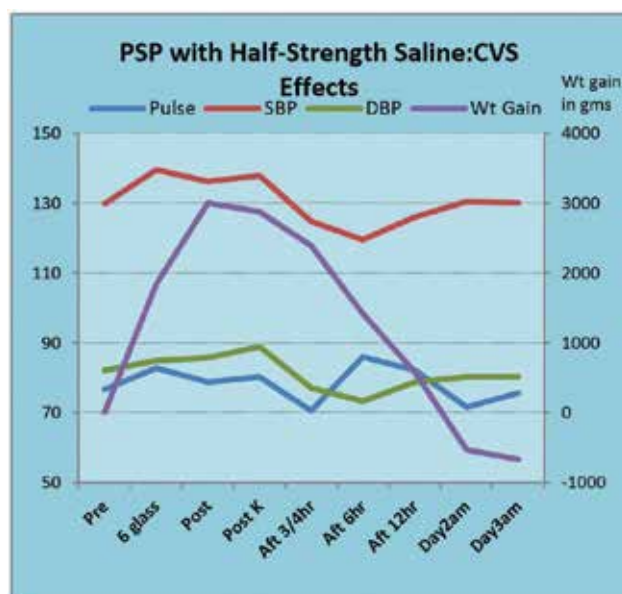
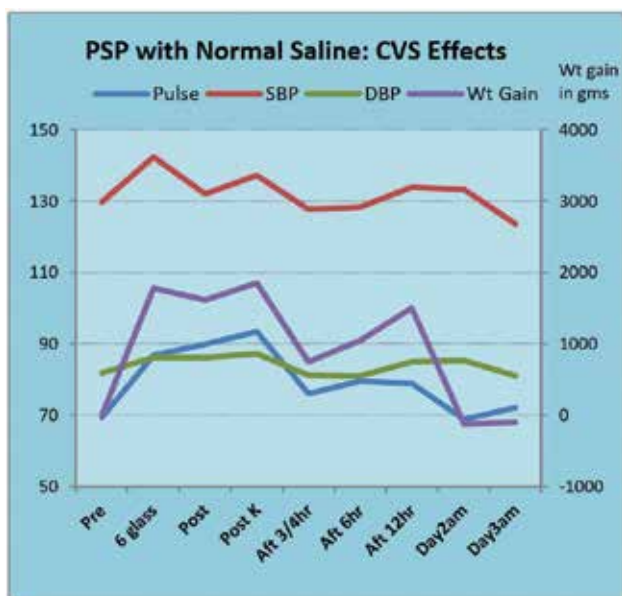
Study 2

The data of 12 diabetic subjects in an Intensive Health Management Research Course (May 2002) in Study 1 of PSP with normal strength saline (group A) was compared with 14 diabetic subjects in an Intensive Health Management Research Course (May 2003) of PSP with half-strength saline (group B) keeping the same parameters as in Study 1.

In both groups there was a uniform rise in pulse-rate throughout the practice due to the effect of physical exertion. After the rest period it settled down. The systolic and diastolic BP rose during the early phase of the practice due to physical exertion. But as the practice progressed they came down towards the baseline due to parasympathetic preponderance. After kunjla a rise in both the BP was noted. The increases in the pulse-rate and BP were lower in group B than in group A and the fall in the pulse-rate during the rest period as well as on days 2 and 3 were more pronounced.

Table 4: Physiological effects of PSP with normal saline and with half-strength saline

Group A n=12	PSP with normal saline			
	<i>Pulse</i>	<i>SBP</i>	<i>DBP</i>	<i>Body wt</i>
<i>Pre</i>	69.42	129.75	81.83	65.33
<i>6 glass</i>	86.75	142.25	86.25	67.12
<i>Post</i>	89.92	131.92	86.08	66.95
<i>Post k</i>	93.42	137.17	87.17	67.18
<i>Aft 3/4hr</i>	76.08	127.75	81.25	66.08
<i>Aft 6hr</i>	79.58	128.33	81.08	66.47
<i>Aft 12hr</i>	78.92	133.92	85.00	66.83
<i>Day 2 am</i>	68.75	133.17	85.42	65.22
<i>Day 3 am</i>	72.08	123.50	80.92	65.22
Group B n=14	PSP with half-strength saline			
	<i>Pulse</i>	<i>SBP</i>	<i>DBP</i>	<i>Body wt</i>
<i>Pre</i>	76.71	129.86	82.07	67.91
<i>6 glass</i>	82.79	139.50	84.86	69.81
<i>Post</i>	78.79	136.07	85.71	70.97
<i>Post k</i>	80.14	137.86	88.86	70.91
<i>Aft 3/4hr</i>	70.50	124.71	77.00	70.36
<i>Aft 6hr</i>	85.86	119.57	73.36	69.39
<i>Aft 12hr</i>	82.14	126.07	78.79	69.54
<i>Day 2 am</i>	71.57	130.43	80.14	67.44
<i>Day 3 am</i>	75.64	129.93	80.21	67.3



In **group A**, the practice of PSP was more effective in cleansing the GI tract. About 63% of the water intake stayed within the GI system and eventually got evacuated through the rectum. The time taken to achieve this was short – by the end of PSP practice. The amount of water intake required was about 4600 ml or little over 15 glasses. About 15% of the water intake was absorbed into the circulatory system and eventually expelled through the kidneys. This route of water disposal is slow.

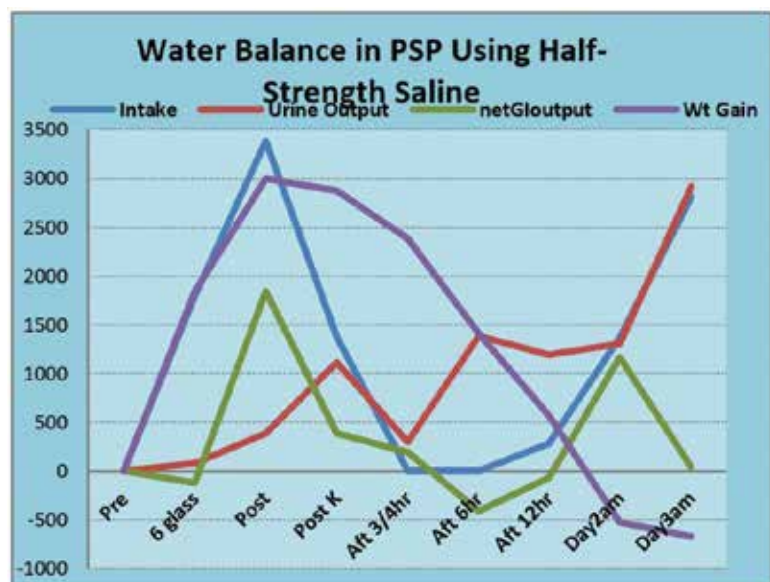
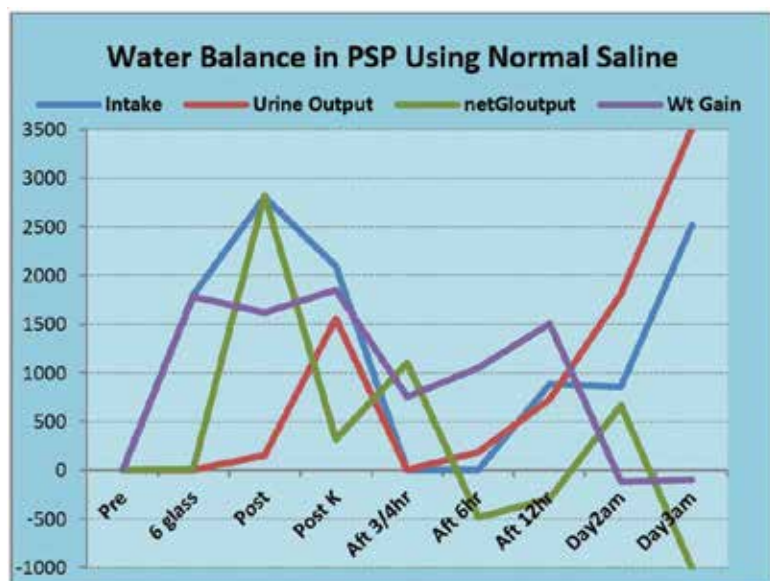
However, for **group B**, the practice of PSP was less effective in cleansing the GI tract. About 35% of the water intake stayed within the GI system and was eventually evacuated through the rectum. The time taken to achieve this was the same – at the end of PSP practice. By this time the remaining water had been absorbed into the circulatory system. The amount of water intake required was about 5200 ml or over 17 glasses. About 50% of the water intake was absorbed into the circulatory system and eventually expelled through the kidneys. This route of water disposal is slow. At the end of the 12-hour time interval 48% out of the expected 50% output was expelled through the urine. Group B took longer than group A to regain the water balance.

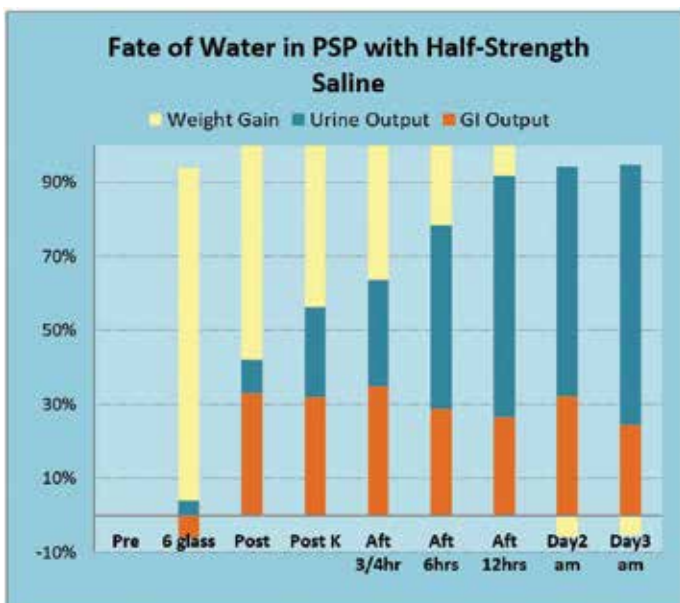
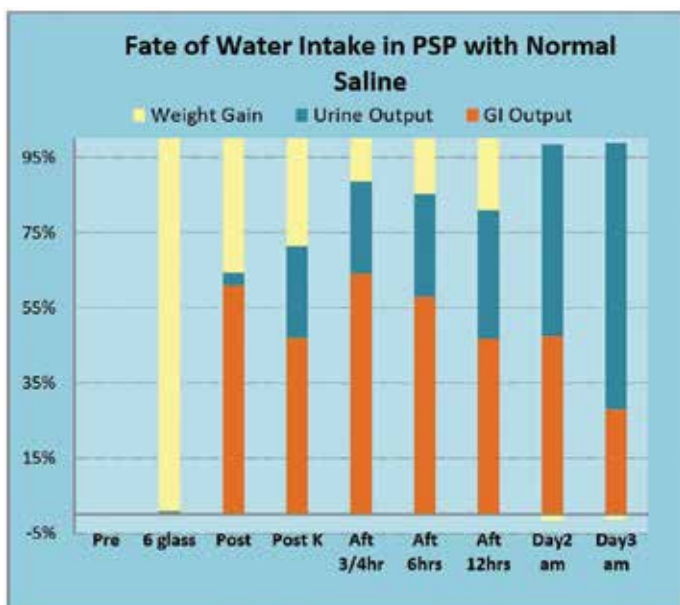
Table 5a: Water dynamics in PSP with normal saline (in ml/gm) (cumulative output/cumulative intake %)

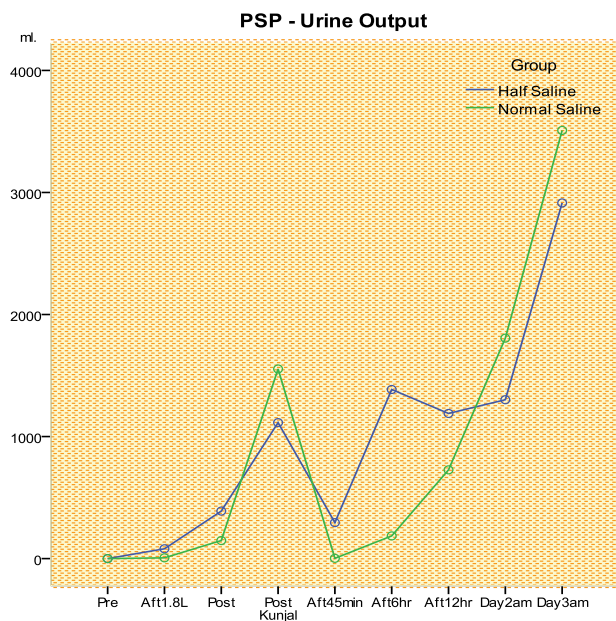
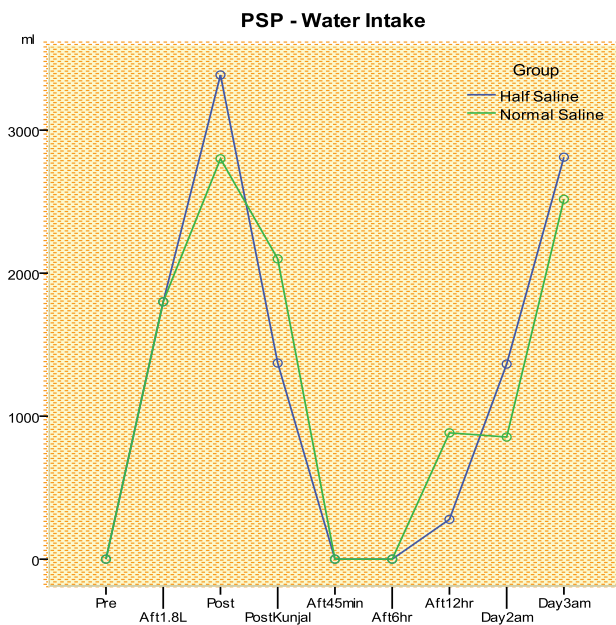
n=12	Intake	Urine+k output	Wt gain	GI output	U+k o/in %	Wt gain/in %	GI o/in %
<i>Pre</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00
<i>6 glass</i>	1800.00	6.25	1783.33	10.42	0.35	99.07	0.58
<i>Post</i>	2800.00	147.92	1616.67	2818.75	3.43	35.65	60.92
<i>Post k</i>	2100.00	1553.75	1850.00	312.92	24.36	28.75	46.89
<i>Aft 3/4hr</i>	0.00	2.08	750.00	1097.92	24.39	11.48	64.13
<i>Aft 6hr</i>	0.00	185.83	1050.00	-485.83	27.42	14.81	57.77
<i>Aft 12hr</i>	883.33	727.08	1500.00	-294.02	34.21	19.12	46.67
<i>Day 2 am</i>	854.17	1806.25	-116.67	664.85	52.60	-1.79	49.19
<i>Day 3 am</i>	2516.67	3508.33	-101.83	-1006.50	72.66	-1.29	28.62

Table 5b: Water dynamics in PSP with half-strength saline

n=14	in ml/gm				cumulative output/ cumulative intake %		
	Intake	Urine+k output	Wt gain	GI output	U+k o/in %	Wt gain/in %	GI o/in %
Pre	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6 glass	1800.00	80.36	1842.86	-123.21	4.46	102.38	-6.85
Post	3385.71	389.29	3000.00	1839.29	9.06	57.85	33.09
Post k	1371.43	1114.29	2871.43	385.72	24.16	43.79	32.05
Aft 3/4hr	0.00	294.64	2385.71	191.07	28.65	36.38	34.97
Aft 6hr	0.00	1385.71	1414.29	-414.29	49.78	21.57	28.65
Aft 12hr	278.57	1189.29	571.43	-67.86	65.15	8.36	26.49
Day 2 am	1364.29	1301.79	-528.57	1162.50	70.19	-6.45	36.26
Day 3 am	2810.71	2914.29	-671.43	39.29	78.74	-6.10	27.36







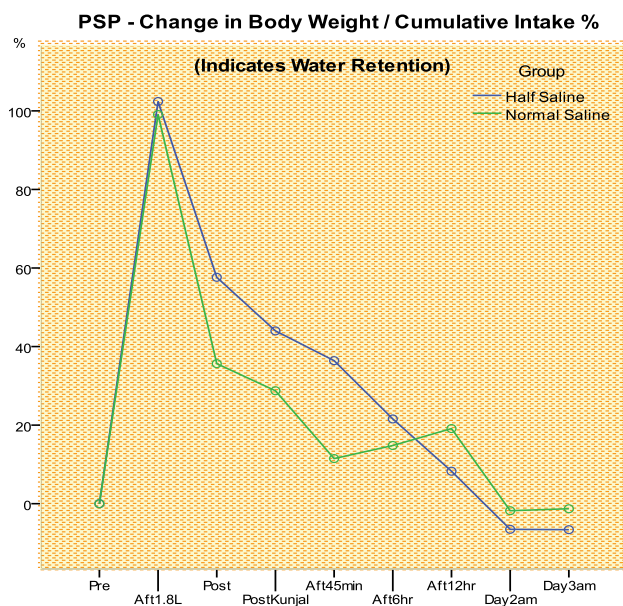


Table 6: Multivariate test of significance for PSP with normal saline and half-strength saline

n=12 normal saline n=14 ½-strength saline	F	Significance	Partial eta squared	Observed power
<i>Pulse-rate</i>	3.282	0.001	0.108	0.970
<i>SBP</i>	0.824	0.583	0.030	0.379
<i>DBP</i>	1.284	0.253	0.045	0.583
<i>Intake</i>	3.836	0.000	0.124	0.988
<i>Wt gain</i>	75.166	0.000	0.736	1.000
<i>Urine output</i>	4.651	0.000	0.147	0.997
<i>Cumulative GI output</i>	3.499	0.001	0.115	0.979
<i>W/I%</i>	7.755	0.000	0.223	1.000
<i>O/I %</i>	4.214	0.000	0.135	0.994
<i>GI O/I %</i>	3.296	0.001	0.109	0.971

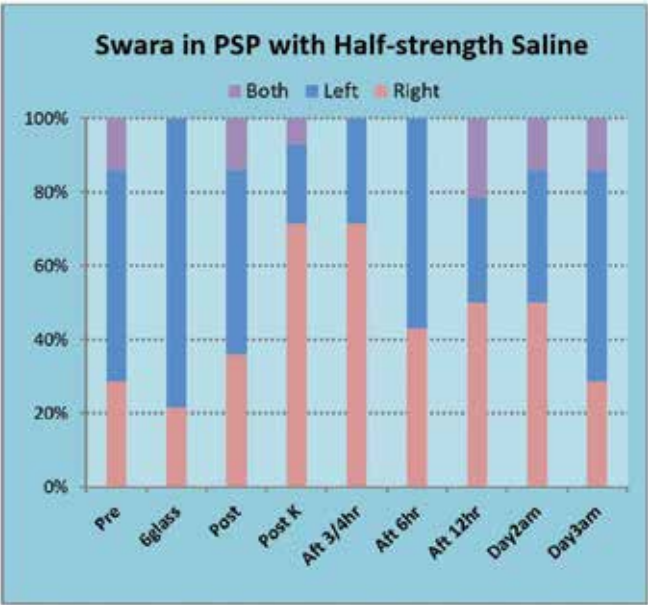
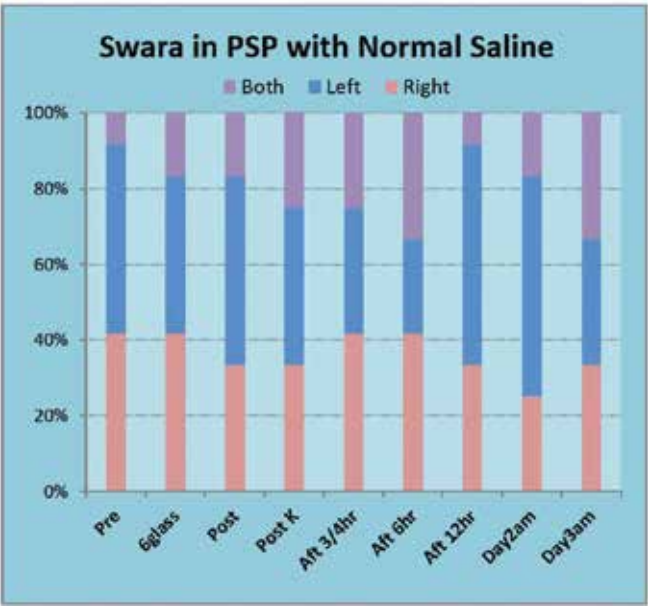
The swara pattern was quite interesting. In the subjects of group A, very little change in swara pattern was noted. In the subjects of group B, there was an initial rise in ida activity followed by profound pingala dominance as the practice progressed and also during the rest period. Spasm of GI tract sphincters (a function of the sympathetic system) leads to pingala dominance or vice versa. Later in the day balance between pingala and ida was achieved.

Table 7: Pattern of swara in PSP with normal saline

n=12	Pre	6 glass	Post	Post k	Aft 3/4hr	Aft 6hr	Aft 12hr	Day 2 am	Day 3 am
<i>Right</i>	5	5	4	4	5	5	4	3	4
<i>Left</i>	6	5	6	5	4	3	7	7	4
<i>Both</i>	1	2	2	3	3	4	1	2	4

Table 8: Pattern of Swara in PSP with Half-strength Saline

n=14	Pre	6 glass	Post	Post k	Aft 3/4hr	Aft 6hr	Aft 12hr	Day 2 am	Day 3 am
<i>Right</i>	4	3	5	10	10	6	7	7	4
<i>Left</i>	8	11	7	3	4	8	4	5	8
<i>Both</i>	2	0	2	1	0	0	3	2	2



Conclusion

There is no deleterious effect of PSP on the cardiovascular system in healthy subjects.

Only 15% of the water is absorbed into the circulatory system in PSP done with normal salt solution, but 50% of the water is absorbed when half-strength salt solution is used. The larger the quantity of water absorbed, the longer the kidneys take to expell it, about 12 hours or more. For people with jeopardized kidney, heart or vascular functions this may not be advisable. One is likely to think that by reducing the salt content the safety of the practice will increase. In fact, by reducing the salt content the practice becomes unsafe. Hence, **it is advisable to observe the contra-indications diligently and to avoid modifying the practice of PSP.**

Effects of Shatkarmas on Lung Functions: Shatkarmas and Spirometry, 1989

In 1989 under the supervision of Dr Aparna the Yoga Research Foundation (YRF) conducted a few studies on the effects of shatkarmas on functions of the lungs as measured through spirometry tests in asthmatics and also in normal subjects. There were four studies with different research designs. We present here the results obtained in these experiments. The results are only indicative as some studies were too small.

Study 1

It is claimed that asthmatics can avert an attack of asthma or regulate the breathing during an attack of asthma using the practice of kunjal kriya. To find evidence to this claim YRF, studied the effects of kunjal kriya on lung function tests. The group consisted of 14 adults, males and females, of whom 6 had history of asthma and 8 were non-asthmatics. The subjects underwent lung function testing on an 'Autospiro AS600' (Minato) machine. They performed kunjal with five 280 ml glasses of warm saline water. Five of them did kunjal only (February 1989 batch) while the remaining nine followed it by neti (November 1989 batch).

Results

Lung functions improved significantly after kunjal, more so in asthmatics. As the subgroups are too small, the test of significance is misleading. Surprisingly, the combination of kunjal and neti was less effective than kunjal singly. See Table 1 and accompanying graphs.

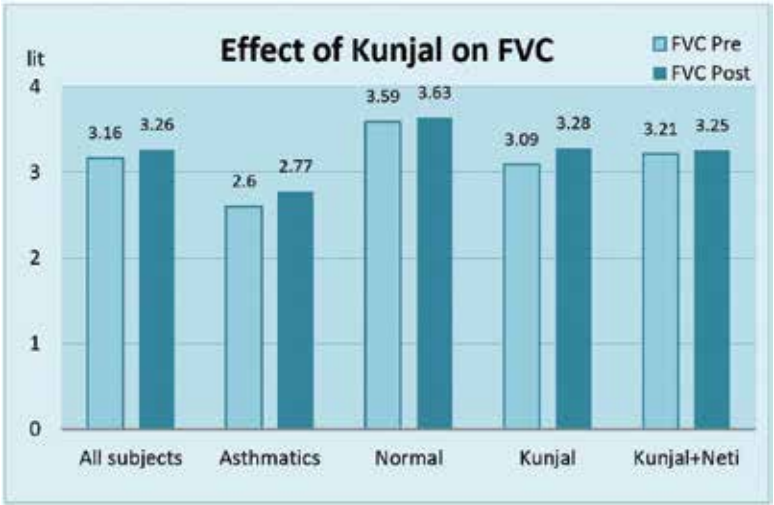
Table 1: Effects of kunjaj/kunjaj+neti on lung function tests

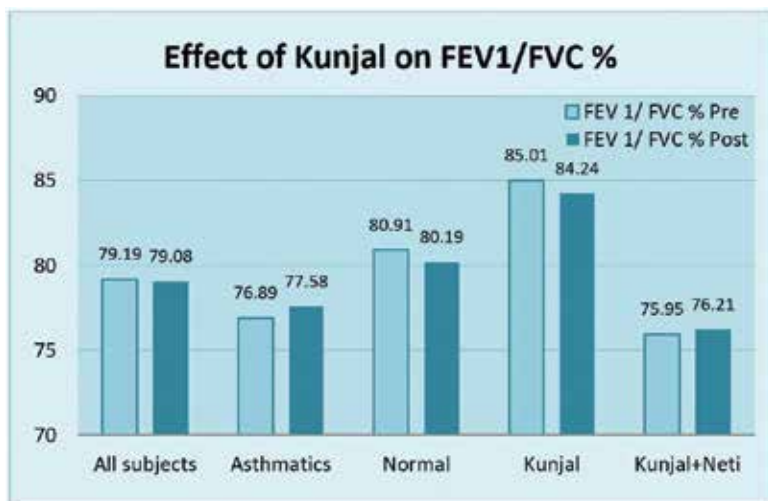
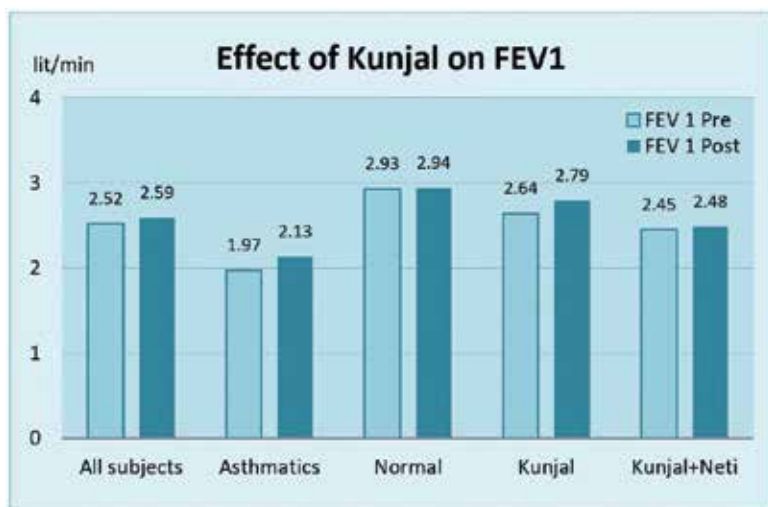
		FVC			FEV 1		
Group	n	Pre	Post	Significance	Pre	Post	Significance
All subjects	14	3.16	3.26	0.0425	2.52	2.59	0.0477
Subgroup type I							
Asthmatics	6	2.60	2.77	0.0801	1.97	2.13	0.0488
Normal	8	3.59	3.63	0.3397	2.93	2.94	0.5878
Subgroup type II							
Kunjaj	5	3.09	3.28	0.1116	2.64	2.79	0.1315
Kunjaj+neti	9	3.21	3.25	0.2233	2.45	2.48	0.1953

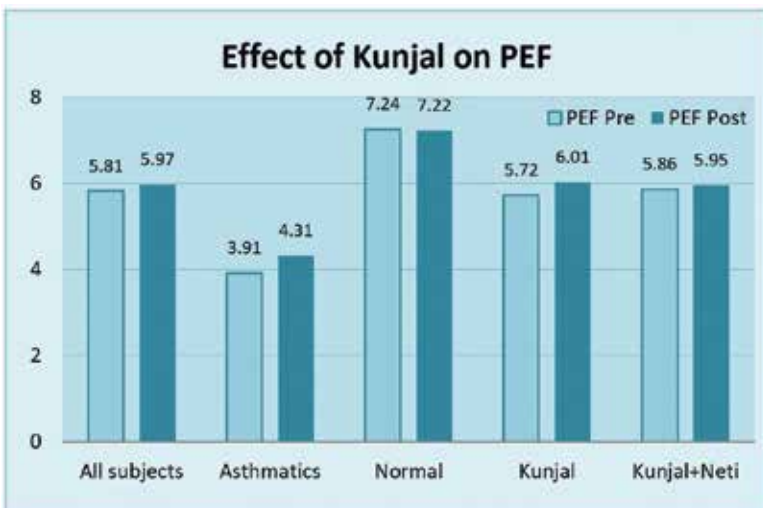
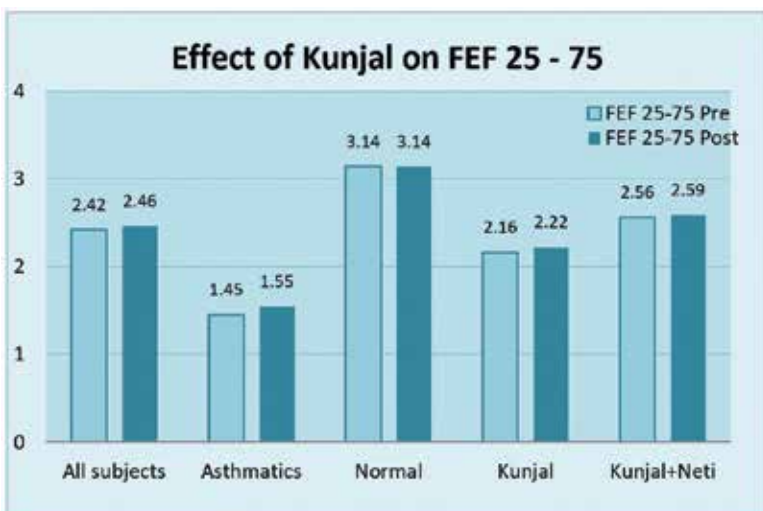
		FEV 1/FVC %			FEF 25–75		
Group	n	Pre	Post	Significance	Pre	Post	Significance
All subjects	14	79.19	79.08	0.8659	2.42	2.46	0.3017
Subgroup type I							
Asthmatics	6	76.89	77.58	0.6259	1.45	1.55	0.1182
Normal	8	80.91	80.19	0.2211	3.14	3.14	0.8835
Subgroup type II							
Kunjaj	5	85.01	84.24	0.5551	2.16	2.22	0.4168
Kunjaj+neti	9	75.95	76.21	0.7461	2.56	2.59	0.5550

		PEF		
Group	n	Pre	Post	Significance
All subjects	14	5.81	5.97	0.1515
Subgroup type I				
Asthmatics	6	3.91	4.31	0.0529
Normal	8	7.24	7.22	0.8768
Subgroup type II				
Kunjaj	5	5.72	6.01	0.2449
Kunjaj+neti	9	5.86	5.95	0.4676

In asthma, smaller air passages, the bronchioles, get constricted causing difficulty in breathing especially during exhalation. Sympathetic stimulation can reverse this constriction by allowing the air passages to relax, dilate, and thereby easing out the difficulty in breathing. The practice of kunjal causes sympathetic stimulation (refer to other studies on kunjal by YRF) and so improves breathing. On the other hand, the practice of neti causes parasympathetic stimulation and so is not very effective in relaxing bronchioles. In normal, non-asthmatic subjects the bronchioles are already optimally relaxed and hence further sympathetic stimulation of kunjal may or may not produce further relaxation. The results of this study are in alignment with these physiological principles.







Study 2

In this study, the effects of the combined practice of kunjal and neti on lung functions and the cardiovascular system (CVS) were studied on 11 normal males and females using an 'Autospiro AS600' to do Pulmonary Function Tests (PFT), and a simple sphygmomanometer and clock for measurement of blood pressure (BP) and heart rate. The PFT, BP and heartrate were first measured twice on one day at an interval of 30 minutes. This served as control data. After five to seven days, the same subjects were tested for the same parameters before and after the practice of kunjal along with neti.

Results

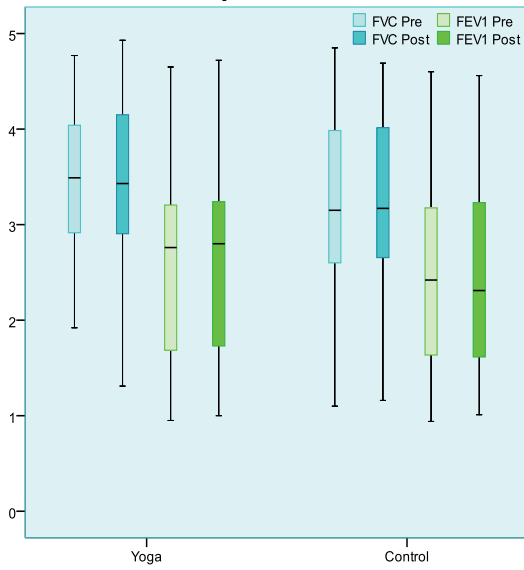
No significant changes were found in PFT or in CVS following kunjal along with neti. There was not much difference between the yoga group and the control group. See Table 2 and accompanying graphs.

As already discussed, in a previous study sympathetic stimulation reversed the constriction of the air passages and eased out the difficulty in breathing. The practice of kunjal causes sympathetic stimulation (refer to other studies on kunjal by YRF) and the practice of neti causes parasympathetic stimulation. In normal, non-asthmatic subjects the bronchioles are already optimally relaxed and hence further sympathetic stimulation or kunjal may or may not produce further relaxation.

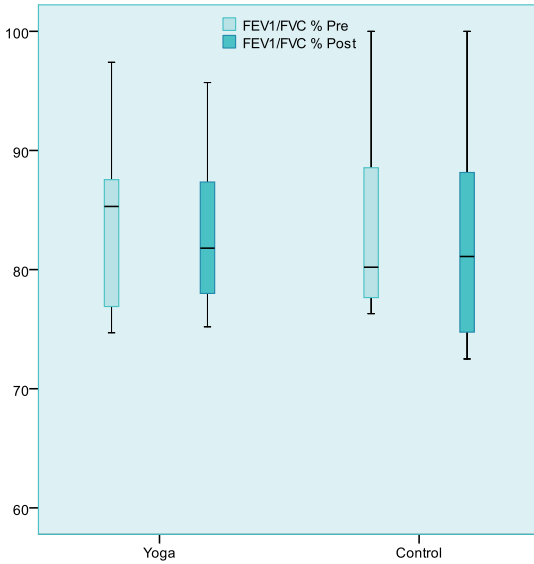
Table 2: Effects of kunjial + neti on lung functions & cardiovascular system in normal subjects

		Yoga (kunjial + neti) n=11				Control (no practice) n=11			
		Mean	Std. deviation	Std. error mean	Significance (2-tailed)	Mean	Std. deviation	Std. error mean	Significance (2-tailed)
FVC	Pre	3.3018	1.04628	0.31546	0.118	3.1327	1.09307	0.32957	0.567
	Post	3.3427	1.05851	0.31915		3.1655	1.11805	0.33710	
FEV1	Pre	2.5691	1.13479	0.34215	0.325	2.4709	1.10677	0.33370	0.627
	Post	2.5909	1.13619	0.34257		2.4500	1.11457	0.33605	
FEV1/ FVC %	Pre	77.2000	18.86870	5.68913	0.880	78.6273	17.63196	5.31624	0.250
	Post	77.0909	19.24284	5.80193		77.7091	18.65848	5.62574	
FEF 25-75	Pre	2.6400	1.77672	0.53570	0.949	2.5800	1.66297	0.50140	0.155
	Post	2.6364	1.70118	0.51292		2.4873	1.65845	0.50004	
PEF	Pre	6.0364	2.81813	0.84970	0.244	5.6609	2.44380	0.73683	0.576
	Post	6.2318	2.82888	0.85294		5.7864	2.47285	0.74559	
SBP	Pre	99.6364	8.42939	2.54156	0.506	105.2727	10.13006	3.05433	0.018
	Post	98.5455	7.69888	2.32130		99.1818	8.20754	2.47467	
DBP	Pre	72.3636	12.45209	3.75445	0.166	70.2727	11.67982	3.52160	0.228
	Post	68.2727	6.23042	1.87854		67.5455	7.11848	2.14630	
HR	Pre	70.6364	8.61711	2.59816	0.163	70.0000	11.22497	3.74166	0.405
	Post	73.0909	11.37941	3.43102		71.3333	10.38027	3.46009	

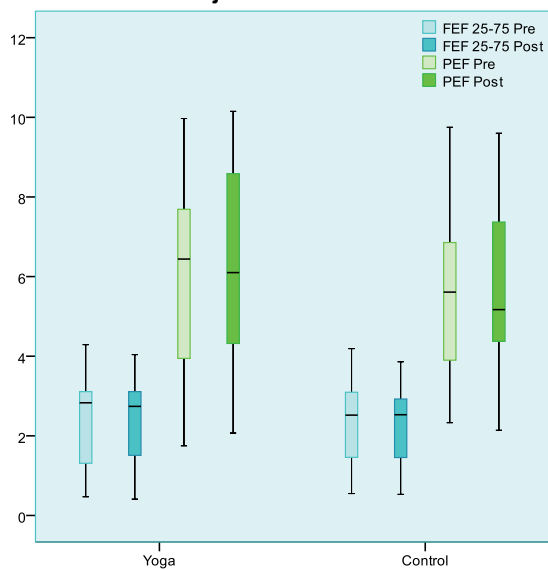
Effects of Kunjal + Neti on FVC & FEV1



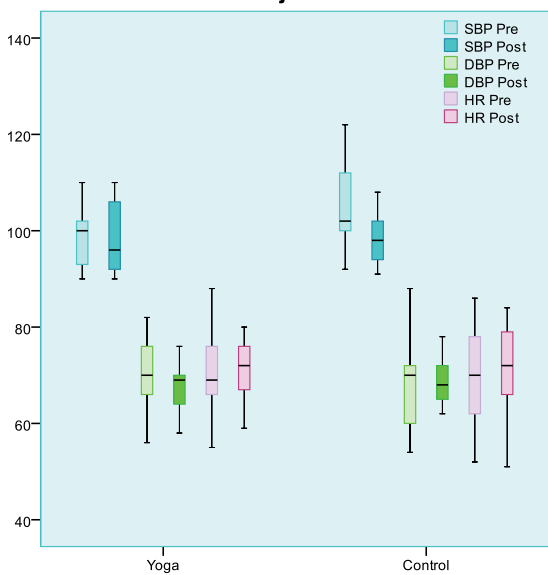
Effect of Kunjal + Neti on FEV1/FVC %



Effects of Kunjal + Neti on FEF 25-75 & PEF



Effects of Kunjal + Neti on CVS



Study 3

In December 1989, immediate effects of combined practice of laghoo shankhaprakshalana (LSP) followed by kunjaj on Lung Function Tests (PFT = Pulmonary Function Test) were studied on 8 asthmatics, male and female. An 'Autospiro AS600' (Minato) was used for lung function testing. On day 1 of the yoga therapy course their PFT was done, more as a practice round. On day 7 again the 'pre' reading was taken. Then they performed LSP with 3 rounds of drinking 2 glasses of warm saline water and doing 5 asanas. It was then followed by kunjaj with five glasses of warm saline water. One glass measured 280 ml. Just after kunjaj, when their breath settled down, the spirometry for PFT was repeated. It is said that in asthmatics breathing is not free in early morning. It tends to improve after a couple of hours. To rule out the influence of this physiological fluctuation in lung function and to establish that the beneficial effect found is due to yoga practices only, we collected yet another 'pre' reading and, 3 hours later, a 'post' reading on the same subjects without intervention of any yoga practices on day 14. This served as the control group.

Results

FVC, FEV1 and PEF tests of PFT showed statistically significant immediate improvement after LSP and kunjaj in asthmatics. The fourth test FEF 25–75 also showed improvement, but it was not statistically significant. In the same subjects at the same time period of a day when these practices were not done the improvement was not observed. The ratio of the first two tests, FEV1/FVC expressed in percentage did not show any change as both nominator and denominator improved to same extent. See Table 3 and the accompanying graphs.

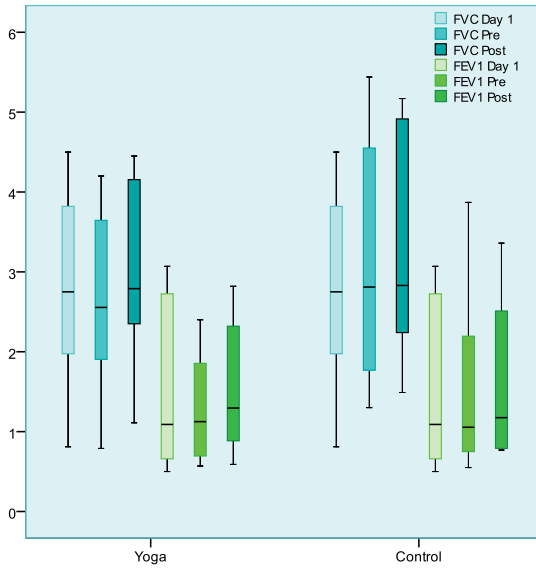
The practice of LSP has an immediate stimulating effect on the sympathetic system but longer lasting overall effect is parasympathetic stimulation (refer to other studies on LSP by YRF). The practice of kunjaj, as already discussed in

previous studies, causes sympathetic preponderance. This study also indicates the same.

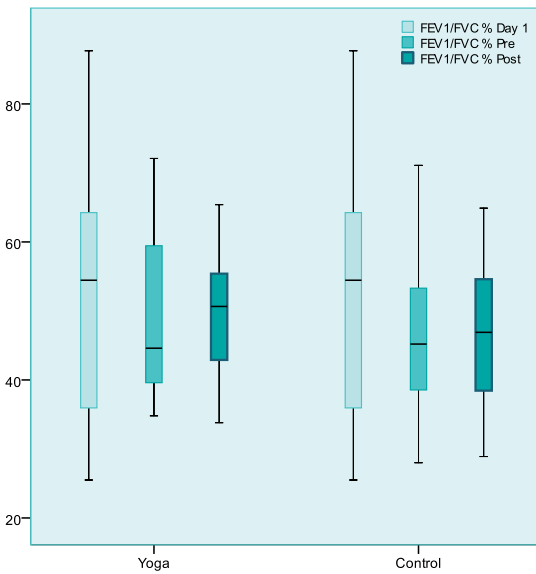
Table 3: Effects of laghoo shankhaprakshalana and kunjial on lung functions in asthmatics

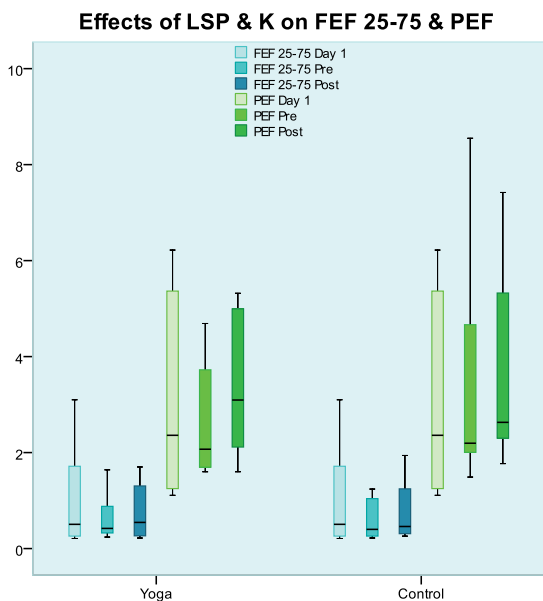
		Yoga (LSP + k) n=8				Control (no practice) n=8			
		Mean	Std. deviation	Std. error mean	Significance (2-tailed)	Mean	Std. deviation	Std. error mean	Significance (2-tailed)
FVC	Pre	2.6500	1.13696	0.40198	0.006	3.1250	1.56155	0.55209	0.091
	Post	3.0188	1.16254	0.41102		3.3288	1.46016	0.51624	
FEV1	Pre	1.2900	0.68619	0.24260	0.003	1.5525	1.15070	0.40683	0.489
	Post	1.5513	0.83333	0.29463		1.6350	1.01451	0.35868	
FEV1/ FVC %	Pre	49.2750	13.88861	4.91037	0.916	46.6500	12.98241	4.58997	0.972
	Post	49.6375	9.84014	3.47902		46.7125	11.41834	4.03699	
FEF 25-75	Pre	0.6413	0.48268	0.17065	0.144	0.7813	0.82734	0.29251	0.983
	Post	0.7687	0.59523	0.21045		0.7787	0.62318	0.22033	
PEF	Pre	2.6588	1.21312	0.42890	0.012	3.4713	2.40730	0.85111	0.373
	Post	3.4163	1.50092	0.53066		3.7125	2.04843	0.72423	

Effects of LSP + Kunjal on FVC & FEV1



Effects of LSP & Kunjal on FEV1/FVC %





Study 4

In December 1989, YRF also studied the immediate effects of laghoo shankhprakashana (LSP) and kunjai individually on lung function in asthmatics by running Pulmonary Function Tests (PFT). ‘Autospiro AS600’ (Minato) was used for lung function testing. This study is too small and may be reported more as an anecdotal finding than a study.

On three asthmatic subjects, all male, pre reading of PFT was collected. They did LSP with 3 rounds of drinking 2 glasses of warm saline water and doing 5 asanas. PFT was repeated just after their breath settled down. It was then followed by kunjai with five glasses of warm saline water. One glass measured 280 ml. Again PFT was repeated just after their breath settled down. To rule out the effects of asanas on PFT the same subjects underwent PFT 2 days later at the same time. This was considered as pre reading for the control group. They practised 3 rounds of asanas of LSP with a couple of minutes break in between. PFT was

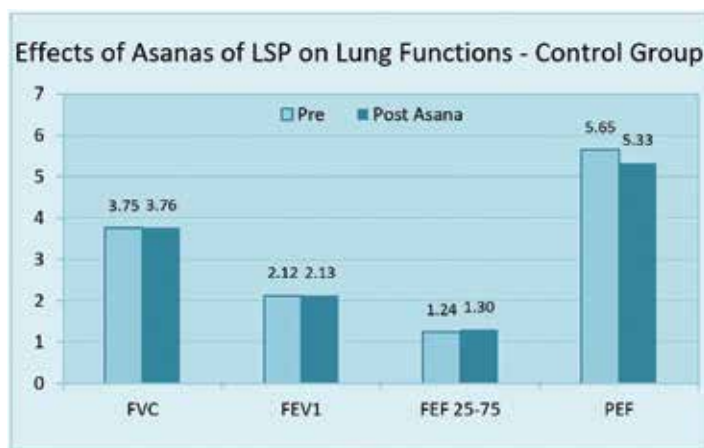
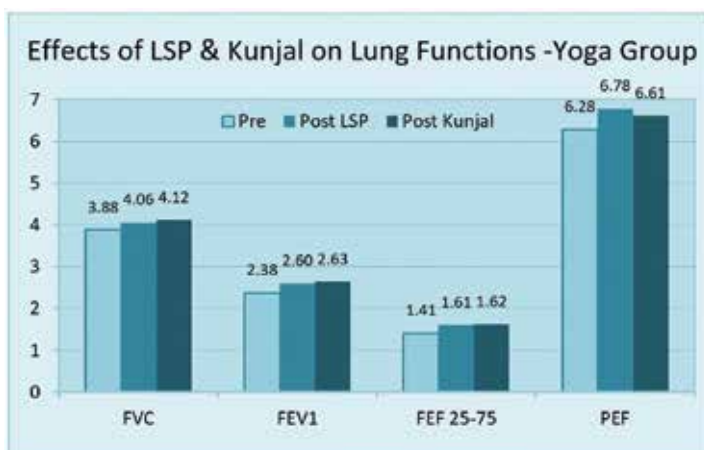
then repeated when their breath settled down. This was considered as post-LSP reading. There was no equivalent to post-kunjai reading in the control group.

Results

PFT showed improvement after LSP in all the five tests. This improvement was further enhanced or maintained after the practice of kunjai. The control group did not show any improvement whatsoever in any of the five tests of PFT. See Table 4 and the accompanying graphs. The physiological effects of LSP and kunjai are already discussed in previous study.

Table 4: Effects of laghoo shankhaprakshalana and kunjai on lung functions in asthmatics

	Yoga (LSP + kunjai) n=3			Control (asanas of LSP) n=3	
	Pre	Post LSP	Post kunjai	Pre	Post asana
FVC	3.88	4.06	4.12	3.75	3.76
FEV1	2.38	2.60	2.63	2.12	2.13
FEF 25-75	1.41	1.61	1.62	1.24	1.30
PEF	6.28	6.78	6.61	5.65	5.33
FEV1/FVC %	61.27	63.83	63.73	56.07	56.03



Conclusion

1. The practice of kunjal is statistically effective in improving PFT values in asthmatics but not effective for normal subjects.
2. The practice of LSP is statistically effective in improving PFT values in asthmatics singly or in combination with kunjal.
3. It is likely that kunjal singly is more effective than kunjal in combination with neti in improving PFT in asthmatics.

Surya Namaskara

Introduction

Surya namaskara, salutation to the sun, is so called because it is practised in the early morning facing the sun. In ancient days, surya namaskara was practised daily in the routine of spiritual exercises.

Surya namaskara is a combined process of yogasanas and breathing. It reduces abdominal fat, gives flexibility to the spine and limbs and increases the breathing capacity. It is easier to perform asanas after doing surya namaskara. It tones up the entire body.

There are twelve spinal positions, each stretching various ligaments and giving different movements to the vertebral column, which is bent forward and backward alternately with deep breathing. When the body is bent forward, the contraction of the abdomen and diaphragm throws the breath out. When the body bends backward, the chest expands and deep breathing follows automatically. Flexibility of the body increases and incorrect breathing is corrected.

—*Swami Sivananda Saraswati*

Surya namaskara is an effective way of loosening up, stretching, massaging and toning all the joints, muscles and internal organs of the body. It is an excellent group of asanas with which to start one's morning practice. Its versatility and application make it one of the most useful

methods of inducing a healthy, vigorous and active life, while at the same time preparing for spiritual awakening and the resulting expansion of awareness.

The Sanskrit name *surya* here refers to the sun and *namaskara* means 'salutations'. Surya namaskara has been handed down from the enlightened sages of the vedic age. The sun symbolizes spiritual consciousness and in ancient times was worshipped on a daily basis. Worship of the outer and inner sun was a religio-social ritual which attempted to placate those forces of nature beyond human control. In yoga the sun is represented by *pingala* or *surya nadi*, the pranic channel which carries the vital, life-giving force.

Surya namaskara is composed of three elements: form, energy and rhythm. The twelve postures create the physical matrix around which the form of the practice is woven. These postures generate *prana*, the subtle energy which activates the psychic body. Their performance, in a steady, rhythmic sequence, reflects the rhythms of the universe: the twenty-four hours of the day, the twelve zodiac phases of the year and the biorhythms of the body. The application of this form and rhythm to the body-mind complex generates the transforming force which produces a fuller and more dynamic life, and a greater appreciation of the world we live in.

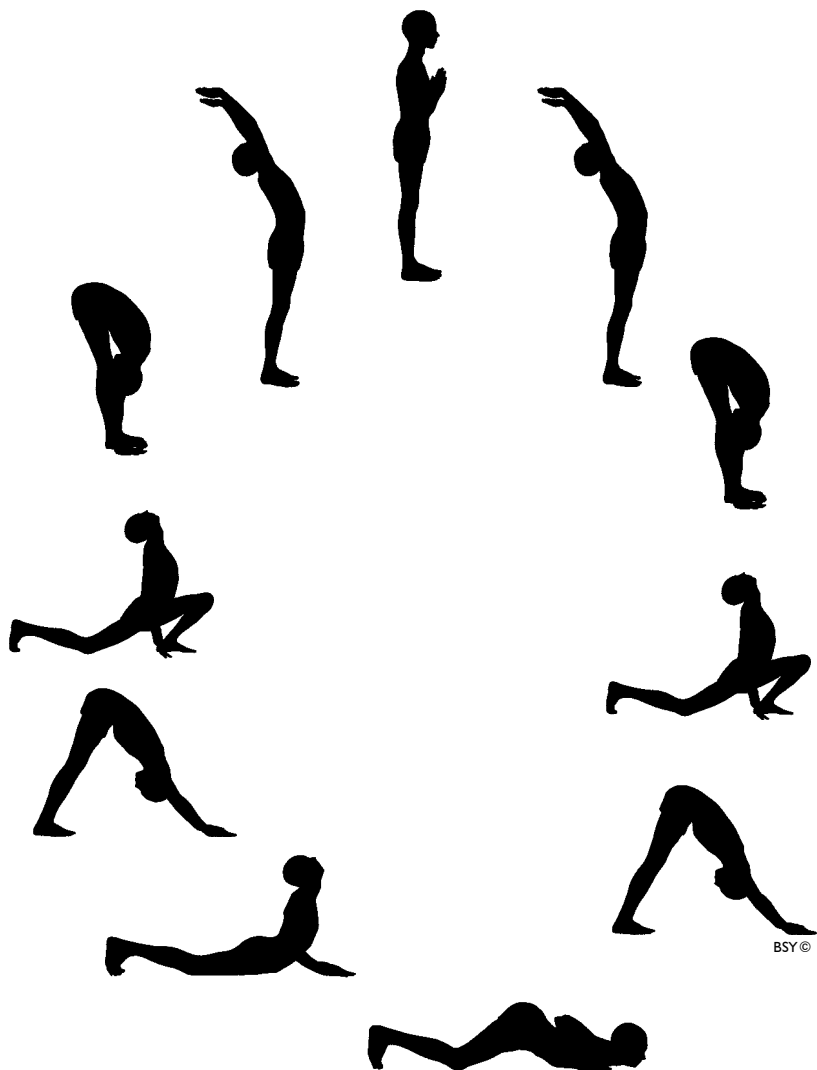
—*Swami Satyananda Saraswati*

Surya namaskara means 'salute to the sun'. It is to be practised in the morning, when it is calm and quiet, when one is fresh and not under tension and stress. It is done to improve the circulation of the blood, to energize the different parts and organs of the body, and to control the breath.

The breath plays a very important role. When one is angry, or tense, or frustrated, one's breathing will become shallow and very fast. When one is relaxed and peaceful, the breathing will be deep and long. Scientifically, it has been proven that the breath controls many activities of the

brain and that with control of the breath, we can alter the state of the mind, reduce the stress level in the brain and nervous system, and experience harmony and tranquility.

—Swami Niranjanananda Saraswati



Surya Namaskara – An Energizing Practice, 2000–2002

As a spiritual practice surya namaskara dates back to the ancient vedic period when the sun was worshipped as a powerful symbol of spiritual consciousness. The practice has since been used to awaken the solar aspects of an individual's nature and release the vital energy for the development of higher awareness.

यत् सर्वं प्रकाशयति तेन सर्वान् प्राणान् रश्मिषु सन्निधत्ते
आदित्यो ह वै प्राणः

Yat sarvam prakaashayati tena sarvaan praanaan rashmishu sannidhatte. Aadityo ha vai praanah.

According to the *Prashnopanishad*, “The Sun is the source of prana or energy for everything that exists on the planet earth. Undoubtedly, the Sun is our Prana.”

प्राणः प्रजानामुददत्येष सूर्यः

Praanah prajaanaamudadatyeshah sooryah.
Shruti reaffirms the same thing.

आ प्रा द्यावापृथिवी अन्तरिक्षं सूर्य आत्मा जगतस्तस्थुषश्च

Aa praa dyaavaaprithivee antariksham soorya atmaa jagatastasthushashchala.

The *Rigveda* says, “The rise of the Sun illumines earth, sky and the space beyond the sky. Sun is the atma, the part of Eternal God, in every moving and non-moving being.” The sun is considered the only manifest form of the Eternal Principle.

In the well-known Gayatri mantra, we worship the sun as the supreme luminous creator of three worlds: earth, sky and the space above the sky. We request the sun to guide our intellect. The sun is the giver of everything that we need: food, water in the form of rain, oxygen, energy, prana, light, vision, warmth, good health, strong intellect, and so on. Worship of the sun is an act of acknowledgment, thanks giving, and a process of receiving this energy. Worship consists of tri-sandhya-vandana: chanting of the Gayatri mantra, other surya mantras and hymns, practices of surya namaskara and nadi shodhana pranayama, and meditation on the Sun. Saura Tantra, one of the five major tantras, (Shaiva, Shakta, Vaishnava and Ganapatya tantras being the other four) is devoted to the practices of sun worship. The practice of surya namaskara as it exists today was later added to the original vedic version of sun worship. The beeja mantras and surya mantras as used in the practice of surya namaskara in Satyananada Yoga originally belonged to Tricha-kalpa-namaskara of Brahmakarma Samuchchaya, a technique of sun worship.

Yogic philosophy describes two types of energies in our bodies. The first, prana shakti, flowing in pingala nadi, is the solar, positively charged energy with masculine characteristics. The second, manas shakti, flowing in the ida nadi, is the lunar, negatively charged energy having feminine characters. The prana shakti is responsible for physical activity, extroversion, dynamism, courage, leadership qualities, aggression, reasoning and logical understanding etc. in an individual. The psychic centre manipura chakra, also known as the solar plexus, located behind the navel in the vertebral column is the storehouse of this prana shakti. In contrast, the manas shakti is responsible for mental activity, introversion, nurture and growth, empathy, qualities of acceptance, adjustment and surrender, creativity i.e. ability to find non-conventional alternatives, intuitive understanding and artistic abilities etc. in an individual.

Both these energies are equally important to deal with the different life situations as well as for spiritual growth. The sympathetic and parasympathetic branches of autonomic nervous system in the physical body may be equated to a great extent to the prana shakti and the manas shakti respectively. The practice of surya namaskara activates this prana shakti and the manipura chakra. The *Suryopanishad* states that people who worship the sun as Brahman become powerful, active and intelligent. They acquire good health and long life. The Puranas recommend that one should pray for good health to the sun.

Awakening of prana shakti bestows on the sadhaka agility, flexibility, good posture, lean body mass, good health, physical strength, good eyesight, courage, dynamism, broad vision, leadership qualities, organizational and administrative ability, self-confidence, clear thinking and sharp intelligence i.e. grasping power, logical analysis and discriminative abilities. The heightened state of prana shakti is necessary not only for facing the external world and its in-built stress but also for day-to-day living.

The Yoga Research Foundation in collaboration with the department of Applied Yogic Science of Bihar Yoga Bharati, Munger, is presenting here a few research studies carried out by the MSc students as their dissertation/experimental project.

- The physical effects of surya namaskara were observed by Dr D.B. Lad (MSc; 2000–2002) and by Ms Nirmala Thomas (MSc; 2003–2005).
- The first study done by Shri Ravi Shankar (MSc; 2001–2003) showed the effect of surya namaskara on pingala/ida or right/left swara dominance.
- The second study done by Ms Nirmala Thomas (MSc; 2003–2005) showed the effect of surya namaskara on self-confidence and some aspects of health.

Some observations on the physical effects of surya namaskara

In his experiment, Dr D.B. Lad found that regular practice of surya namaskara reduces body weight and the abdominal girth. He experimented with 12 young men (age 16 to 22 years) of Munger, Bihar, India, doing twelve dynamic rounds of surya namaskara for one month. He found that the reduction in abdominal girth was disproportionately higher than reduction in body weight. The conclusion derived is that surya namaskara burns excess fat tissue and preserves or builds muscle mass in the body. His results are presented in Table 1.

Table 1: Effects of surya namaskara on body weight and abdominal girth

n=12	Pre	Post
<i>Mean body weight in kg</i>	49.66	48.38
<i>Mean abdominal girth in cm</i>	73.33	69.25

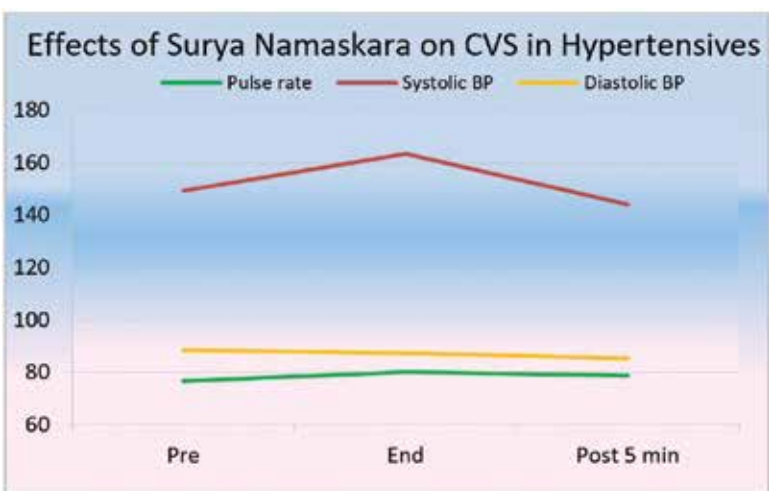
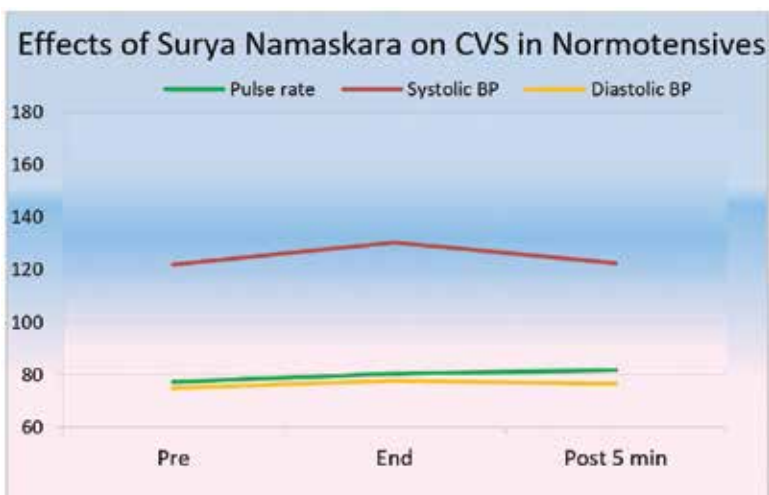
In her experiment Ms Nirmala Thomas found that regular practice of surya namaskara improves the posture, overall general health and relieves minor menstrual complaints. Her results are presented in detail in the second experiment.

Yet another study was conducted at the Yoga Research Centre run by Kasturba Hospital, BHEL, Bhopal, in collaboration with Bihar School of Yoga. In the year 2006–2007 subjects of research projects on asthma and diabetes were observed for cardiovascular effects of 3 rounds of surya namaskara done with moderate speed. Of these 27 subjects, 11 had normal BP and 16 were hypertensive. In both groups the pulse-rate increased but the rise was significant only in the high BP group. In both groups, systolic BP also increased at the end of practice significantly, much more in the high BP group. The diastolic BP however increased marginally only in the normal BP group. Interestingly, the high BP group showed a tendency to fall in diastolic pressure and

though the systolic BP rose initially it dropped to below pre level in 5 minutes. See Table 2 and accompanying graphs. We still do not recommend the practice of surya namaskara to hypertensives as the combination of rise in systolic BP as well as pulse-rate is very unsafe even if it is temporary.

Table 2: Effects of surya namaskara on cardiovascular system

	Normal BP (n=11)				
	<i>Pre</i>	<i>End</i>	<i>Post 5 min</i>	<i>Signifi pre:end</i>	<i>Signifi pre: aft 5 min</i>
<i>Pulse-rate</i>	77.27	80.55	81.64	0.258883	0.023627
<i>SBP</i>	122.09	130.45	122.45	0.021199	0.865904
<i>DBP</i>	74.91	77.91	76.45	0.234321	0.311101
	High BP (n=16)				
	<i>Pre</i>	<i>End</i>	<i>Post 5 min</i>	<i>Signi pre:end</i>	<i>Signifi pre: aft 5 min</i>
<i>Pulse-rate</i>	76.69	80.13	78.88	0.006766	0.158873
<i>SBP</i>	149.19	163.25	144.00	0.000878	0.074116
<i>DBP</i>	88.31	87.31	85.38	0.500691	0.080368



Study 1: Effects of surya namaskara on swara pattern in asthmatics

Hypothesis

Regular practice of surya namaskara for one month will correct the ida dominance in asthmatics.

Method

Subjects: Twenty asthmatics, 8 females and 12 males, from Barh, Bihar, India, were selected for the experiment. Their age ranged between 25 to 45 years. None of them had any other major disease. Depending on their willingness to do yoga regularly they were assigned to either the experimental or the control group.

Parameter

Record of dominance of nasal flow (right or left) at sunrise and sunset time.

Procedure

All the subjects were taught the method of checking nasal flow dominance (swara) using their hands. They were given a diary to note down their swara five times during the day, on waking, at sunrise, at noon, at sunset and at bedtime. Only the record of swara at sunrise and sunset times were analyzed.

The experimental group was introduced to the practice of surya namaskara. They were given two slow and five fast rounds of the practice daily for thirty days. They were not introduced to mantras or chakra awareness during the practice. There was no intervention with the control group. Both the groups were not practising any other yogic practices. They did not make any changes in their lifestyle just prior to or during the experimental period.

Results and analysis

As per the science of swara yoga the pattern of swara is predetermined and is in tune with the lunar movement.

On a given lunar day a certain swara should be dominant at sunrise and at sunset. Deviation from the normal pattern indicates imbalance at one or more than one kosha levels. We calculated only the abnormal swara pattern at sunrise and sunset in all the subjects.

Table 3 shows the abnormal swara in the first week (pre value) and the last week (post value) of the experiment in the experimental group.

Table 3: Swara pattern in experimental asthmatic group

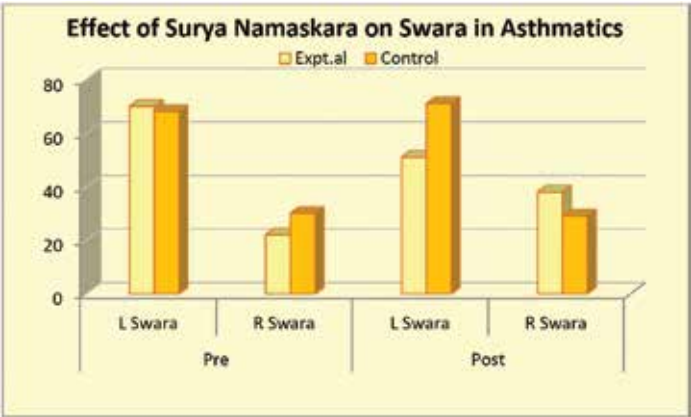
Subject (n=10)	Pre (first 7 days)		Post (last 7 days)		Remark
	<i>Left dominant</i>	<i>Right dominant</i>	<i>Left dominant</i>	<i>Right dominant</i>	
1	9	3	6	6	Less left dominance
2	6	1	6	2	Insignificant change
3	9	4	5	4	Less left dominance
4	8	2	3	4	Change to right
5	5	3	6	4	Insignificant change
6	9	2	5	4	Less left dominance
7	6	2	6	4	Less left dominance
8	7	3	5	4	Less left dominance
9	8	1	4	3	Less left dominance
10	3	1	5	3	Insignificant change
Total	70	22	51	38	Less left dominance

Out of 10 subjects, 7 subjects showed diminished left swara dominance or change towards right swara dominance and 3 subjects showed insignificant change.

Table 4 shows the abnormal swara in the first week (pre value) and the last week (post value) of the experiment in the control group.

Table 4: Swara pattern in control asthmatic group

Subject (n=10)	Pre (first 7 days)		Post (last 7 days)		Remark
	Left dominant	Right dominant	Left dominant	Right dominant	
1	9	4	9	5	Insignificant change
2	7	3	7	3	No change
3	7	3	7	4	Insignificant change
4	7	3	8	3	More left dominance
5	5	3	5	3	No change
6	8	3	9	2	More left dominance
7	6	3	7	3	More left dominance
8	8	3	9	3	More left dominance
9	6	3	7	2	More left dominance
10	5	2	3	1	Less left dominance
Total	68	30	71	29	More left dominance



Out of 10 subjects, 5 subjects showed more left dominance; 4 subjects showed no or insignificant change and 1 subject showed decrease in left dominance. Asthma is a typical health disorder of ida nadi dominance. The change of swara dominance from ida to pingala with the help of surya namaskara actually reduced the symptoms of asthma in the subjects.

Conclusion

The dynamic practice of surya namaskara stimulates pingala nadi or the right nasal flow and helps in the management of asthma.

Study 2: Effects of surya namaskara on the level of self-confidence and menstrual problems

Hypothesis

Regular practice of surya namaskara for three months will improve self-confidence and relieve minor menstrual complaints in young women.

Method

Subjects: Fifty students of Providence Women's College Hostel in Calicut, Kerala, India, were selected as subjects. The selected group consisted of young women aged 18 to 23 years. None of them had any major disease. All were staying in the same hostel and having the same lifestyle.

Parameters

1. Self-confidence questionnaire ASCI – Pre, after 3 months
2. Height while seated – Pre, after 3 months
3. Menstrual history questionnaire – Pre, after 3 months
4. General health questionnaire – Pre, after 3 months

Procedure

The subjects were allotted into experimental and control groups according to their willingness to practise yoga regularly. Fifteen women of this group were not interested

in doing yoga. They were kept in the control group and the remaining 35 were included in the experimental group. The above-mentioned three questionnaires were administered after due explanations and their height while seated was measured using a measuring tape while they were comfortably sitting on the floor in a cross-legged posture.

The experimental group was introduced and led to the practice of 12 rounds of dynamic surya namaskara by the end of the second week. Mantra chanting and chakra awareness were not included in the practice. The yoga class was conducted regularly for one month. The subjects were then asked to continue with the practice on their own for another two months. One person dropped out from the experiment. All the four parameters were collected again.

Results and analysis

Self-confidence of the subjects was measured using the Agnihotri Self-Confidence Index (ASCI) questionnaire. The results show that after three months of regular surya namaskara practice, the self-confidence level improved significantly in the experimental group while in the control group there was a little deterioration; the score dropped from 31.56 to 25.38. Both the scores are within the ‘average’ group but at the extremes of the range. That means the subjects traversed from low-average to high-average level. The results are not only statistically significant but significant in practical life. See Tables 5 and 6 and accompanying graphs.

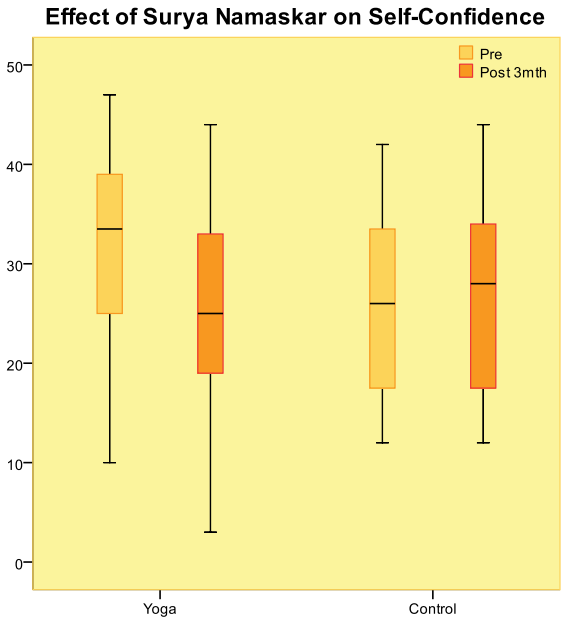
Table 5: Interpretation of ASCI score

Score	Interpretation
7 and below	Very high
8–19	High
20–32	Average
33–44	Low
45 and above	Very low

Table 6: Effect of surya namaskara on self-confidence (ASCI score)

		Mean	Std dev	t value	df	Significance
Yoga (n=34)	<i>Pre</i>	31.56	9.20	5.05	33	0.000
	<i>Post</i>	25.38	9.69			
Control (n=15)	<i>Pre</i>	25.53	10.30	2.05	14	0.06
	<i>Post</i>	26.27	10.76			

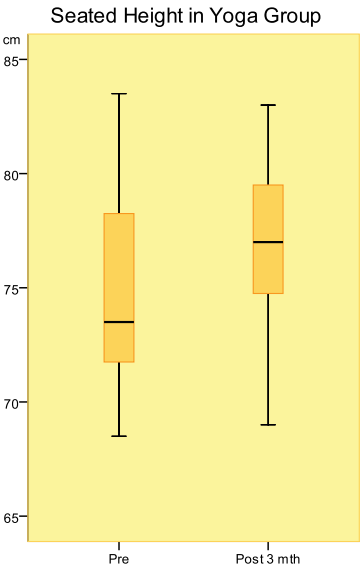
		25 percentile	50 percentile	75 percentile
Yoga (n=34)	<i>Pre</i>	24.75	33.50	39.00
	<i>Post</i>	18.75	25.00	33.25
Control (n=15)	<i>Pre</i>	16.00	26.00	35.00
	<i>Post</i>	17.00	28.00	35.00



As a physical measure of self-confidence, change in the posture of the subjects was observed in 15 subjects by measuring their height while sitting cross-legged. A self-confident person sits erect and hence the height is comparatively more than when he is not confident. The data in Table 7 shows significant change in seated height of the subjects in yoga group.

Table 7: Seated height in cm

n=15	Pre	Post
Mean	75.13	76.97
Std dev	4.41	3.61
t test		0.027



The menstrual history questionnaire inquired into three aspects of menstrual problems: the regularity, the menstrual flow and the pain accompanying menstruation. The experimental group showed great improvement in menstrual complaints. In the control group there was no change in the problems at the end of three months. The general health questionnaire revealed improved energy level and better health in the experimental group and almost no change in the control group. See Table 8.

Table 8: Frequency table for menstrual complaints, health complaints and energy levels

		Yoga		Control	
		Pre	Post	Pre	Post
Menstrual regularity	<i>Regular</i>	26	29	13	13
	<i>Irregular</i>	8	5	2	2
Menstrual flow	<i>Scanty</i>	2	2	0	0
	<i>Normal</i>	31	32	15	15
	<i>Heavy</i>	1	0	0	0
Menstrual pain	<i>None</i>	10	14	5	5
	<i>Reduced</i>	—	8	—	—
	<i>Present</i>	24	12	10	10
Health problems*		29	17 improved	2	No change
Low endurance		2	2 improved	None	None
Appetite			9 improved		None
Concentration			4 improved		None
Immunity			1 improved		None

* Different health problems reported by the subjects:

Irregular bowel habit	Joint pain
Digestive problem	Breathing difficulty
Severely painful menstruation	Acidity
Allergy	Back pain
Migraine	

Conclusion

The regular practice of surya namaskara for at least three months in this population of test subjects appeared to raise self-confidence, improve posture, help manage menstrual complaints and boost overall general health.

Pranayama

Introduction

Prana is the universal principle of energy or force. It is vital force. Prana is all-pervading. It may be either in a static or dynamic state. It is found in all forms, from the lowest to the highest, from the ant to the elephant, from the unicellular amoeba to a man, from the elementary form of plant life to the developed form of animal life.

It is prana that shines in your eyes. It is through the power of prana that the ear hears, the eye sees, the skin feels, the tongue tastes, the nose smells, the brain and the intellect perform their respective functions. The smile on the face of a young lady, the melody in music, the power in the emphatic utterances of an orator, the charm in the words of one's own beloved wife – all these and many more have their origin in prana.

Fire burns through prana. Wind blows through prana. Rivers flow through prana. The steamer and the airplane, the train and the motor car move about only through the power of prana. Radio waves travel through prana. Prana is electron. Prana is proton. Prana is force. Prana is magnetism. Prana is electricity. It is prana that pumps blood from the heart into the arteries. It is prana again that does digestion, excretion and secretion.

Prana is expended by thinking, willing, acting, moving, talking, writing, and so on. A strong and healthy man has an abundance of prana or vitality. The prana is supplied

by food, water, air and solar energy. The supply of prana is received by the nervous system. The prana is absorbed in breathing. The excess of prana is stored up in the brain and nerve centres.

Prana and mind are intimately related to each other. If prana is controlled, the mind will be controlled. If the mind is controlled, the prana will be automatically controlled. Prana is related to mind, and through it to will, and through will to the individual soul, and through the individual soul to the Supreme Soul.

—*Swami Sivananda Saraswati*

Pranayama is the science of the universal energy, of universal mind, of universal time, space and matter. That is the complete meaning of pranayama. The practice of pranayama has a direct link, a direct effect on the most intricate and sophisticated functioning of the brain. It is not the air one breathes that constitutes pranayama, it is the vital, universal pranic energy which is present in all people, and which has to be dynamized and redistributed. That is the science of pranayama.

Pranayama is not simply a respiratory exercise, or an exercise of the breath. Pranayama does not mean controlling the life force. Pranayama does not mean controlling the breath. Then what is pranayama? Pranayama means conveying the life force to every nook and corner of the body.

It is actually a process which awakens the dormant prana, the sleeping vital energy in the physical body. It is part of a total system of reintegration, rebalancing and reharmonizing of body and mind, a system which purifies and strengthens, and thereby eliminates physical and mental tension and weakness. Simultaneously, pranayama awakens the inner awareness.

—*Swami Satyananda Saraswati*

Disease occurs when there is a block of prana. Headache occurs when there is a block of prana. Eyesight is lost when there is a block of prana in the eyes, hearing is lost when there is a block of prana in the ears, and speech is lost when there is a block of prana at the throat in the speech centre. Digestion becomes sluggish when there is a loss of prana in the digestive system. Muscles become weak when there is a loss of prana in the muscular system. Nervous tensions and nervousness arise when there is a loss of prana in the nervous system. Respiratory problems occur when there is a loss of prana in the respiratory organs. Many yogis practise pranayama as their sadhana. They have no blocks in their body; they are in optimum health.

The word 'pranayama' has two etymological explanations. Firstly, pranayama has been interpreted as a combination of the words 'prana' and 'ayama'. The word *ayama* means 'expanding the dimension', so in the first sense pranayama means expanding the dimension of prana. Each person has abilities and limitations. Each person is involved in a routine, from morning until night. According to this routine and its activities, peaks and lows of energy are experienced. If one is able to increase the length of the peaks by expanding the quality of the prana shakti within, then there is less tiredness. The moment one energizes oneself with pranayama, there is an expansion of prana shakti. The area of pranic activity increases. This is one meaning of pranayama.

Another meaning of pranayama is controlling and guiding the flow of prana as it manifests through the senses and through the mind. The word *yama* means 'restraint' or 'control', so here 'prana' plus 'yama' refers to holding, restraining or controlling the prana shakti. One begins to hold on when it is realized that the energies are being wasted in useless pursuits of the senses which are not going to give satisfaction or happiness, instead withdrawing and focusing the attention on something else. That is holding back, withdrawing, restraining the association of the senses with the sense objects.

When one withdraws the prana shakti the senses become weak and then the corresponding part in the mind also loses its intensity. Obsessive desires become dissipated, not focused. They lose their obsessive quality and simply become a desire which can be adjusted, accommodated and even manipulated.

Medical science has done a significant amount of research on the effects of pranayama over the last few decades. Once translated as 'breathing exercises', pranayama is now recognized by scientists throughout the world as a means of invigorating, enhancing and accelerating the revitalizing processes of the body.

In general, pranayama practice helps to resolve physical and mental disturbances. Respiratory problems end as the art of correct breathing is mastered. As one becomes capable of controlling the breath, initially by simply observing it, many mental problems like anger, despondency and worry cease. When these types of effects are experienced in daily life it is sometimes thought that managing physical and mental health is the only aim of pranayama, but when the rishis discovered the science of pranayama they did not have yoga therapy in mind.

The practitioner of pranayama will certainly experience many benefits at the physical level. These effects have been documented scientifically, and it has been observed that pranayama influences almost all the organs and physiological systems. The main objective of pranayama, however, is to balance the interacting processes of the pranic and mental forces for awakening the higher centres of human consciousness: the real purpose of pranayama is to awaken the pranas, chakras and kundalini.

—*Swami Niranjanananda Saraswati*

NADI SHODHANA PRANAYAMA

Inhale air through the left nostril, and then exhale through the right. Draw it in again through the right and then exhale through the left. To those who practise it according to these rules, through the right and left nostrils, the nadis become purified.

—*Swami Sivananda Saraswati*

The most important pranayama is nadi shodhana. *Nadi* means the network of nerves. They are physical, vital and psychic, carrying nervous impulses, pranic energy and thoughts respectively. *Shodhana* means the process of purification or throwing out of toxins and harmful elements. So the meaning is, 'purification of the nadis'.

Nadi shodhana becomes effective when one is able to breathe in and out to the same count. When the length of the breath is regulated, the entire nervous system associated with the respiratory system is being changed. After all, even in the respiratory system there are nerves which are responsible for the expulsion of air and the intake of air. If a certain rhythm or beat is maintained for breathing in and breathing out, then these nerves inside the lungs and nostrils have to change their natural rhythm and adopt a different one: this different beat helps create a change.

Nadi shodhana pranayama is so effective that it only has to be done for about ten minutes every morning; not even ten, five will suffice. Five rounds can easily be practised each morning, increasing the number as one feels ready to, up to ten or twenty rounds.

—*Swami Satyananda Saraswati*

Nadi shodhana is truly a balancing pranayama as whether the imbalance lies in the physical or mental body, it is a practice that can restore equilibrium. Nadi shodhana is

practised by alternating the inhalation and exhalation between the left and right nostrils, thus influencing the ida and pingala nadis and the two brain hemispheres. This leads to control of the oscillations of the body-mind network, bringing balance and harmony throughout the system.

As a daily practice, nadi shodhana may be used to vitalize the pranic energies, release pranic blockages and achieve a balance between the sympathetic and parasympathetic nervous systems, so that life's situations can be handled better. As a therapeutic tool, it can be applied for almost all physical and mental disorders, although this must be done under expert guidance. For those who wish to use nadi shodhana as a spiritual practice, it may indeed awaken the dormant shakti and direct it through sushumna, the path of spiritual awakening, leading to deep states of meditation.

—*Swami Niranjanananda Saraswati*

UJJAYI PRANAYAMA

As the breath fills the space from the throat to the heart during inhalation a peculiar sound is produced owing to the partial closing of glottis. The sound produced during inhalation should be of a mild and uniform pitch. It should be continuous also. This removes the heat in the head. The practitioner becomes very handsome. The gastric fire is increased.

—*Swami Sivananda Saraswati*

Ujjayi means 'victorious'; *ujji* is the root which means 'to conquer' or 'acquire by conquest'. In English, ujjayi is known as the 'psychic breath' because of its effect on the mind.

In the neck there are two remarkable organs called the carotid sinuses. They are situated on each side of the main

artery supplying the brain with blood, in front of the neck and just below the level of the jaws. These small organs help to control and regulate blood flow and pressure. If there is any fall in blood pressure, it is detected by these two sinuses and the relevant message is sent directly to the brain centre. The brain responds immediately by increasing the heartbeat and contracting the arterioles (tiny blood vessels), thus raising the pressure to its normal level. Any rise in blood pressure is also detected by the carotid sinuses, which inform the brain, and the opposite steps are taken to rectify the situation.

Tension and stress are associated with high blood pressure. Ujjayi pranayama, by applying a slight pressure on these sinuses in the neck, causes them to react as though they have detected high blood pressure, with the result that the heartbeat and the blood pressure are reduced below normal – so one becomes physically and mentally relaxed. This is the reason why ujjayi is so important in many meditation practices. It induces overall relaxation, which is essential for success in meditation.

Ujjayi pranayama is a simple practice but it has many subtle influences on the body and brain, both physical and mental as well as pranic. The slow, deep breathing results in immediate calmness of the mind and body, and also brings the pranic body into harmony. Furthermore, the sound at the throat tends to soothe one's whole being. If one remains aware of this sound for a reasonable period of time to the exclusion of other thoughts, the benefits are felt immediately.

Ujjayi is one of the most important, yet one of the simplest pranayamas. It is a deep breathing practice which induces a meditative state. It is practised by contracting the glottis. With each breath there should be a continuous sound emitted from the throat. When done correctly, ujjayi sounds soft like a cat purring or light snoring. When a healthy child sleeps at night, he always breathes by contracting his glottis, and the breath can be heard in his throat. Ujjayi

is perfected by relaxing the breath rather than forcing it. If one concentrates on the throat and relaxes the breath, it will feel as if the breathing is through the throat.

—*Swami Satyananda Saraswati*

Ujjayi is classified as a tranquillizing pranayama and it also has a heating effect on the body. This practice is used in yoga to soothe the nervous system and calm the mind. It has a profoundly relaxing effect at the psychic level. It helps to relieve insomnia and may be practised in shavasana just before sleeping. The basic form, without breath retention or bandhas, slows down the heart rate and is useful for people suffering from high blood pressure.

Ujjayi removes disorders of the *dhatu*, which are the seven constituents of the body, blood, bone, marrow, fat, semen, skin and flesh. With the practice of ujjayi, the practitioner does not suffer from kapha disorders, constipation, dysentery, intestinal ulcers, colds, fever or liver problems.

—*Swami Niranjanananda Saraswati*

BHASTRIKA PRANAYAMA

Bhastrika relieves inflammation of the throat, increases gastric fire, destroys phlegm, removes diseases of the nose and chest including asthma and consumption, and ensures a good appetite. It gives warmth to the body. In a cool region, practise this pranayama to protect the body from cold – it will quickly generate sufficient warmth in the body. The number of rounds in bhastrika depends on the strength and capacity of the practitioner.

—*Swami Sivananda Saraswati*

Bhastra are the bellows used to fan a fire. Thus the practice can be called 'the bellows pranayama'. This practice is so called because air is drawn forcefully and quickly in and out of the lungs as through the bellows of a village blacksmith. The blacksmith increases the flow of air into a fire in order to produce more heat for his work. *Bhastrika* pranayama can be said to do the same thing: it increases the flow of air into the body, producing inner heat, both gross and subtle. The inner fire of the mind-body is stoked. This heat burns up impurities, whether physical impurities such as toxins, pranic blockages, or mental neuroses.

Bhastrika pranayama is for people who have an active, restless mind. People who are restless cannot keep their mind at one point, even for one second. If they try to concentrate on one point, they find after a few seconds that their mind is thinking of something else and they didn't know it.

Bhastrika pranayama removes physical impurities by increasing the metabolic rate and increasing blood circulation. It is therefore a first rate technique for purifying the blood, improving skin complexion and removing eruptions such as boils and pimples.

At the energetic level, *bhastrika* increases the flow of prana throughout the whole pranic body, helping to induce good health and remove disease at more subtle levels. The pranic body is recharged. Pranic movement, particularly in the coccygeal, navel, thoracic and brain centres, is accelerated by the practice of *bhastrika*, increasing physical vitality and bestowing clarity of mind. *Bhastrika*, therefore, makes the mind one-pointed, preparing the body-mind for meditation.

—*Swami Satyananda Saraswati*

When *bhastrika* pranayama is practised systematically and conscientiously, the benefits are innumerable. Due to the rapid exchange of air in the lungs, there is an increase in the exchange of oxygen and carbon dioxide into and out

of the bloodstream. This stimulates the metabolic rate throughout the body down to the cellular level, producing heat and flushing out wastes and toxins. If one is caught in the cold without sufficient warm clothing, bhastrika can be practised to warm the body quickly.

Bhastrika is a process of hyperventilation, leading to respiratory alkalosis, which has a soothing effect on the respiratory centre. It reduces the level of carbon dioxide in the blood; hence a better kumbhaka can be performed after the practice. The rapid and rhythmic movement of the diaphragm also massages and stimulates the visceral organs, toning the digestive system and improving its blood circulation. The massage also strengthens the muscles of the intestines and other organs in the abdominal cavity, providing the organs adequate support from the front, so that they do not cause a stretch on the lumbar spine, which is often the cause of lower back pain. It is a useful practice for women during labour, if they have had proper preparation.

Bhastrika helps balance the *doshas* or humours: *kapha*, phlegm; *pitta*, bile; and *vata*, wind. It helps to alleviate inflammation in the throat, accumulation of phlegm and sinusitis, and builds up resistance to coughs, colds and excess mucus. It also balances and strengthens the nervous system, inducing peace, tranquillity and one-pointedness of mind.

The practice of bhastrika increases vitality and lowers levels of stress and anxiety by raising the energy and harmonizing the pranas. It increases the generation of samana vayu, which replenishes the pranic store and stimulates the whole pranic system. While practising, all the pranas in the body begin to vibrate, but at the end of the practice the mind is completely stilled. In fact, the meditative state can be reached effortlessly through the practice of bhastrika.

—Swami Niranjanananda Saraswati

KHECHARI MUDRA

By the practice of khechari mudra the yogi becomes free from fainting, hunger, thirst and laziness. Khechari is the best of all mudras.

—*Swami Sivananda Saraswati*

The simple form of khechari mudra is also known as nabho mudra. To practise this form the tongue is simply rolled backwards so that the lower surface touches the soft upper palate. The tip is brought as far back as possible and kept there for as long as possible, from half a minute to ten or twenty minutes. It is suitable for most people, although it still takes a long time to perfect.

—*Swami Satyananda Saraswati*

Khechari mudra, the tongue lock, is regarded as a very important practice in all the hatha yoga, raja yoga and vedantic texts because of its effect on the body and mind. It is generally combined with ujjayi pranayama and other meditation techniques.

—*Swami Niranjanananda Saraswati*

Bhastrika Pranayama, 2004

Introduction

In some of the Yoga Upanishads only nadi shodhana is mentioned as a pranayama practice. No doubt it is the most important pranayama, however, some scriptures describe pranayamas other than nadi shodhana.

Yoga Kundali Upanishad classifies pranayamas into two types: sahita and kevala. Sahita pranayamas have *pooraka*, inhalation, and *rechaka*, exhalation. Kevala pranayamas are without pooraka or rechaka. They have only *kumbhaka*, retention of breath. Until kevala pranayama is accomplished, sahita must be practised. Sahita pranayamas are of four types: surya, ujjayi, sheetali and bhastrika.

This Upanishad further describes the process of bhastrika pranayama in detail. It says, sitting in padmasana with neck and abdomen in a straight line, keep the mouth closed and exhale through the nose with effort. Inhale rapidly up to the lotus of the heart with a resonating sound from the neck to the forehead. Similarly, exhale and inhale again and again like the rapidly moving bellows of a blacksmith. In this manner cautiously move the air in your own body. When the body gets tired, exhale through the right nostril. Inhale filling up the stomach fully and hold the nose without using the first and the second fingers (nasikagra mudra). After performing kumbhaka exhale through the left nostril.

Describing the effects of the practice, the Upanishad further states, that the kumbhaka of bhastrika removes *vata*, air element, from the neck region and enhances the fire element in the body. It excites kundalini, encourages auspiciousness, removes sin and gives happiness. It destroys mainly kapha dosha at the opening of Brahma nadi. It purifies the three gunas and pierces the three granthis. This Upanishad especially recommends the practice of bhastrika kumbhaka with the three bandhas.

Inspired by the scripture and the teachings of Swami Satyananda Saraswati and Swami Niranjanananda Saraswati as expounded in *Asana Pranayama Mudra Bandha* and *Prana and Pranayama* (Yoga Publications Trust), YRF decided to study some of the effects of bhastrika pranayama.

Aim

To study the effects of various stages of bhastrika pranayama at the physical, physiological, pranic and psychological levels.

STUDY I

Method

Nineteen young healthy students of the Department of Applied Yogic Science, Bihar Yoga Bharati, Munger, along with their two yoga teachers undertook this research as a self-study project in the year 2004.

Research design

- Uncontrolled, repeated measure.
- t test (paired two-tailed) and F statistics (General linear model, repeated measure) using SPSS 17 software

Parameters

See Table 1.

Physical

1. BP (mmHg): Baseline, every week 3 readings – before, just after and 5 minutes after the practice of bhastrika pranayama – for 5 weeks;
2. Pulse-rate (per min): Baseline, every week 3 readings – before, just after and 5 minutes after the practice of bhastrika pranayama – for 5 weeks;
3. Breath holding time (sec): Baseline, every week 2 readings – before and after the practice of bhastrika pranayama – for 5 weeks

4. Peak expiratory flow rate (lit/min): Baseline, every week 2 readings – before and after the practice of bhastrika pranayama – for 5 weeks
5. Body temperature (Celsius): Baseline, every week 3 readings – before, just after and 5 minutes after the practice of bhastrika pranayama – for 5 weeks
6. Body weight (kg): Baseline and at the end of the experiment.

Pranic

7. Swara: Baseline, every day readings – before, just after and 5 minutes after the practice of bhastrika pranayama – for 5 weeks by self-reporting (diary)
8. Awareness of chakras: Daily 4 readings – before, during & just after the practice and throughout the day – for 5 weeks by self-reporting (diary).

Psychological

9. State of mood (percentile) using 8SQ test: Baseline and at the end of the experiment
10. State of mind: Happiness, alertness and peacefulness: Daily 4 readings – before, during and just after the practice and throughout the day – for 5 weeks by self-reporting (diary)
11. State of energy: Daily 4 readings – before, during and just after the practice and throughout the day – for 5 weeks by self-reporting (diary).

Table 1: Flow chart for data collection

	Baseline	Every week					Post
Parameter		Pre (resting)	During	Just after	5 min after	Through- out day	
Sys & dias BP	#	#		#	#		
Pulse-rate	#	#		#	#		
BHT	#	#		#			
PEFR	#	#		#			
Body temp	#	#		#	#		
Body wt	#						#
Swara	#	#		#	#		
Chakra awareness	#	#	#	#		#	
Mood (8SQ test)	#						#
Sad/ Happy	#	#	#	#		#	
Dull/alert	#	#	#	#		#	
Agitation/ peace	#	#	#	#		#	
Fatigue/ energetic	#	#	#	#		#	

The baseline data was collected for all the 21 subjects. They were asked to practise 5 rounds of bhastrika pranayama in progressive stages each week using the technique of the Satyananda Yoga tradition. Each round consisted of bellows breathing, using first the left nostril, then the right nostril and finally using both nostrils. Please refer to *Asana Pranayama Mudra Bandha* by Swami Satyananda Saraswati. Every week the subjects progressed in their practice. On

the seventh day of each week data was collected as shown in Table 1. The subjects also maintained a daily diary of their experience of the practice.

The progressive stages of bhastrika pranayama practised are as follows. In week 0 or preparatory week, they practised 20 breaths in each nostril at the rate of 30 breaths/min; in week 1, 20–40 breaths in each nostril at the rate of 30–60 breaths/min; in week 2, 50–75 breaths in each nostril at the rate of 60 breaths/min. In week 3, external kumbhaka was added and in week 4, maha bandha in the external kumbhaka was added. See Table 2.

Table 2: Progressive stages of bhastrika pranayama

	No of breaths in a round	Speed (breaths/min)
Week 0 – preparatory	20 each nostril (20:20:20) x 5 rounds	30
Week 1	20 to 40 each nostril x 5 rounds	30–60
Week 2	50 to 75 each nostril x 5 rounds	> 60
Week 3	50 to 75 each nostril with external kumbhaka x 5 rounds	45 to > 60
Week 4	50 to 75 each nostril with mahabandha in external kumbhaka	45 to > 60

RESULTS AND DISCUSSION

i) Effect on CVS

I. Systolic blood pressure

BP was observed every week before, just after and 5 minutes after the practice of bhastrika pranayama. Every week systolic BP (mmHg) decreased immediately after the practice, except in week 3 when external kumbhaka was introduced. The readings after 5 minutes showed a tendency to rise again partially. Resting or pre-reading of systolic BP

increased marginally over 5 weeks indicating sympathetic stimulation. In about 30% to 35% of subjects it increased (by more than 5 mmHg) and in 15% to 25% of subjects it decreased (by more than 5 mmHg) substantially. See Table 3 and the accompanying graphs.

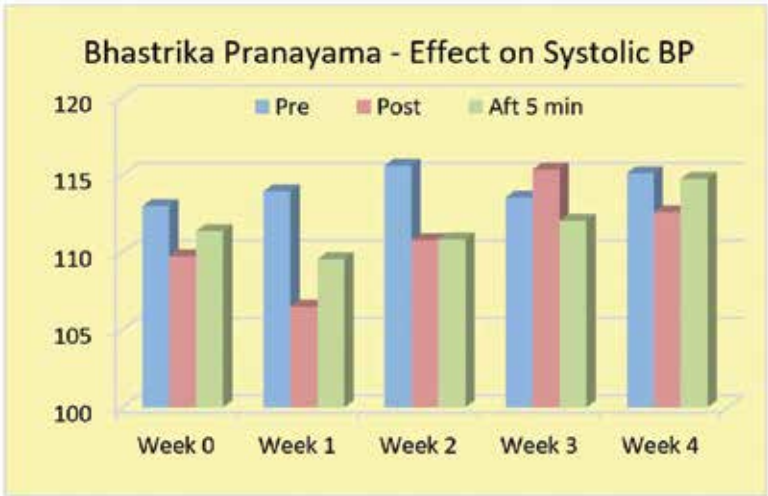
These findings are not in alignment with the common belief that BP would rise after bhastrika pranayama. In bhastrika pranayama CO₂ is washed out due to hyper-ventilation. This in addition to sympathetic stimulation would lead to peripheral vaso-constriction and rise in BP. Also the exaggerated rate and depth of inhalation would increase venous return leading to additional increase in BP. At the pranic level the bellows type breathing is also expected to stimulate manipura chakra and release pranic energy. One then expects a rise in BP. Some subjects with a tendency to hypertension did show a rise in BP in this study, but generally the BP readings showed a downward trend. CO₂ wash-out produced during bhastrika pranayama leads to cerebral vaso-constriction and light-headedness and a feeling of a bliss-like state. This altered state of body pH may lead to a reduction in BP.

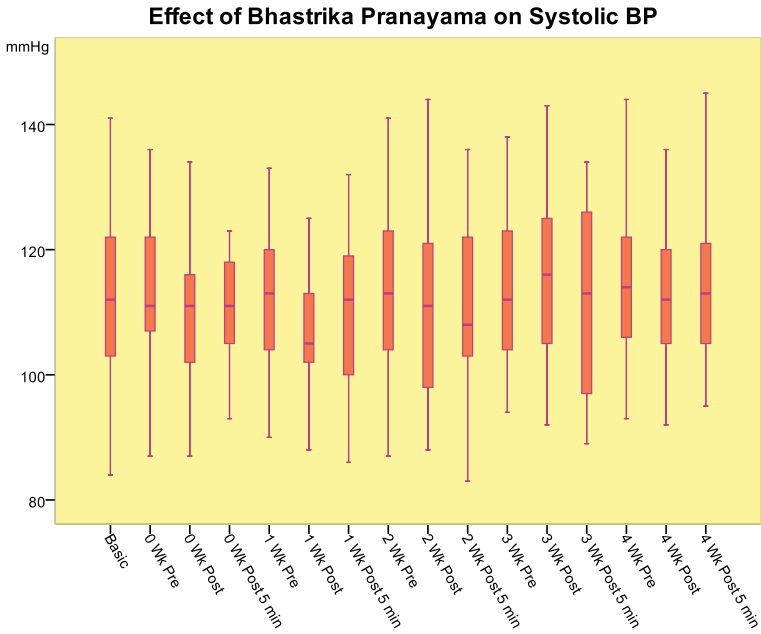
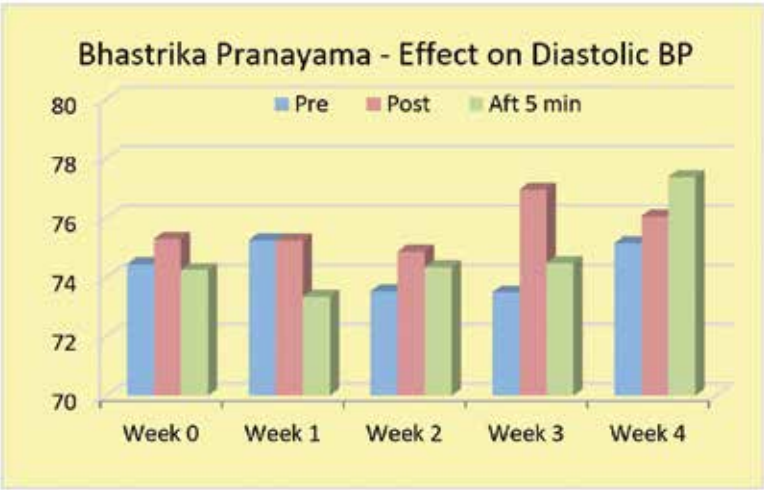
II. *Diastolic blood pressure*

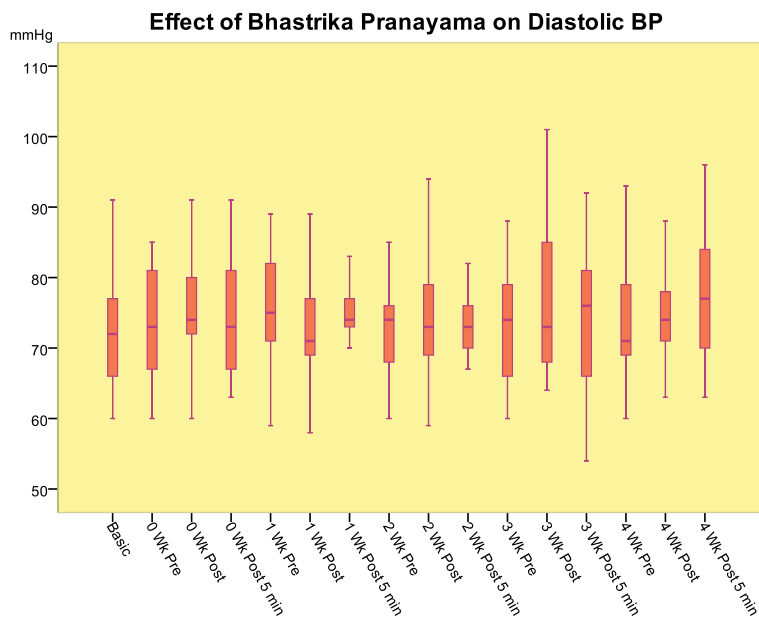
Diastolic BP (mmHg) increased negligibly immediately after the practice, except in week 3, when external kumbhaka was introduced, the rise was substantial (3.5 mmHg). The readings after 5 minutes showed a tendency to come back to pre-reading. The mean resting diastolic BP (pre) did not show much change over the five weeks. In about 20 to 43% of subjects it increased substantially (>5 mmHg) and in the same number of subjects it decreased (by more than 5 mmHg). See Table 3 and the accompanying graphs.

Table 3: Effect of bhastrika pranayama on systolic and diastolic BP

n=21	Week 0	Week 1	Week 2	Week 3	Week 4
Systolic BP					
Pre	113.00	113.95	115.62	113.57	115.14
Post	109.76	106.52	110.81	115.38	112.62
After 5 min	111.38	109.57	110.86	112.05	114.76
F	0.922	5.190	2.799	1.867	0.663
Significance	0.415	0.016	0.086	0.182	0.527
Diastolic BP					
Pre	74.43	75.24	73.52	73.48	75.14
Post	75.29	75.24	74.86	76.95	76.05
After 5 min	74.24	73.33	74.33	74.48	77.38
F	0.391	4.158	0.424	3.423	2.288
Significance	0.682	0.032	0.661	0.054	0.129





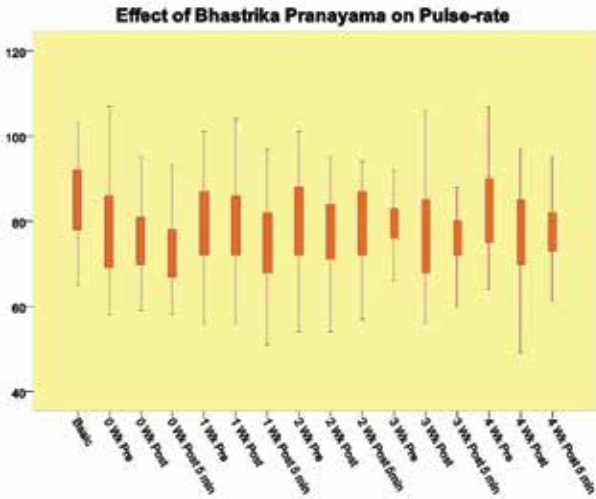
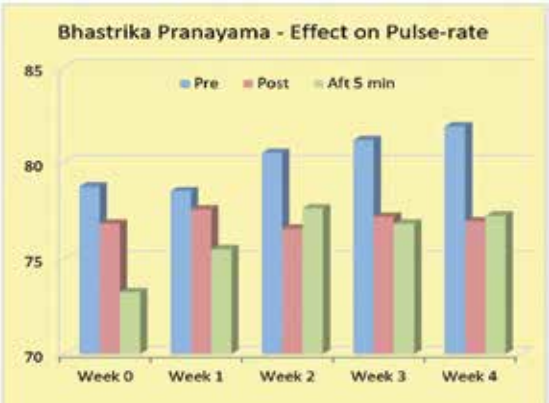


III. *Pulse-rate*

Every week pulse-rate (per minute) decreased immediately after the practice and the fall either continued or was maintained at the end of further 5 minutes. It came down to 76–77 per minute irrespective of the speed and number of breaths per cycle of bhastrika pranayama. The fall was 1–2 per minute in 0–1 weeks and 4–5 per minute in 2–4 weeks. The fall in pulse-rate approaching normal values indicates a more calm and relaxed state of mind. It could also be a compensatory response to an elevated rate during the actual practice, sympathetic stimulation followed by compensatory parasympathetic overtone. The resting pulse-rate (pre) showed a tendency to rise from week 2–4 indicating overall sympathetic stimulation. See Table 4 and the accompanying graphs.

Table 4: Effect of bhastrika pranayama on pulse-rate

n=21	Week 0	Week 1	Week 2	Week 3	Week 4
Pre	78.76	78.52	80.52	81.19	81.91
Post	76.81	77.57	76.57	77.19	76.95
After 5 min	73.24	75.48	77.62	76.81	77.24
F	6.729	1.726	1.684	7.889	2.888
Significance	0.006	0.205	0.212	0.003	0.080



ii) Effect on RS

I. Breath-holding time (BHT)

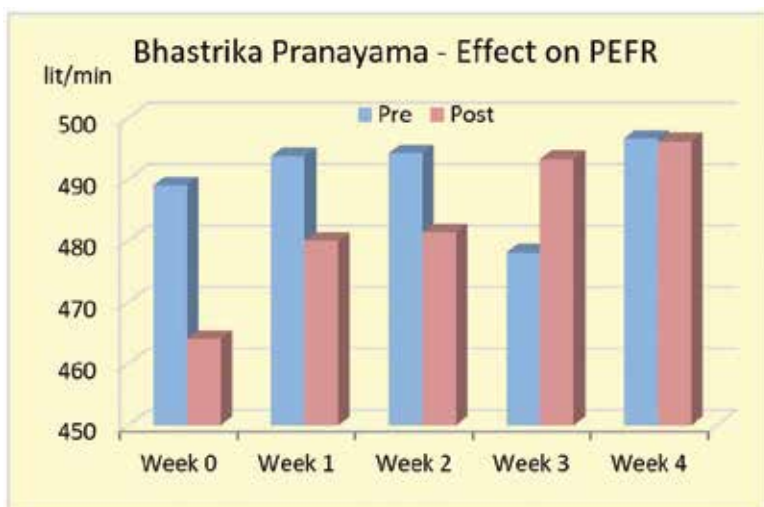
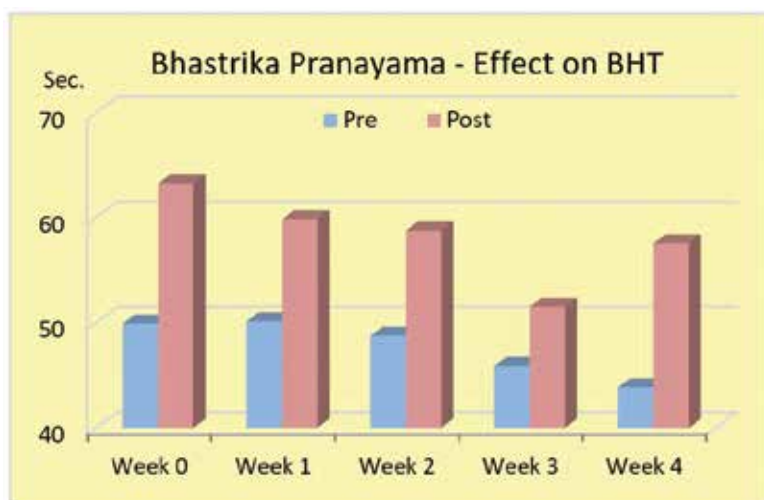
Breath-holding time is a gross measure of cardio-respiratory efficiency. Bhastrika pranayama washes out carbon dioxide (CO₂) from the blood stream. The respiratory drive or the desire to breathe gets temporarily suspended thus the increasing breath-holding time (BHT). Every week the BHT (seconds) showed improvement after bhastrika pranayama. The improvement was less marked in week 3 when external kumbhaka was introduced. The progressive resting values of BHT did not show much improvement. This means, 5 weeks of graded practice of bhastrika pranayama did not improve cardio-respiratory capacity to any significant level. See Table 5 and the accompanying graphs.

II. Peak expiratory flow rate (PEFR)

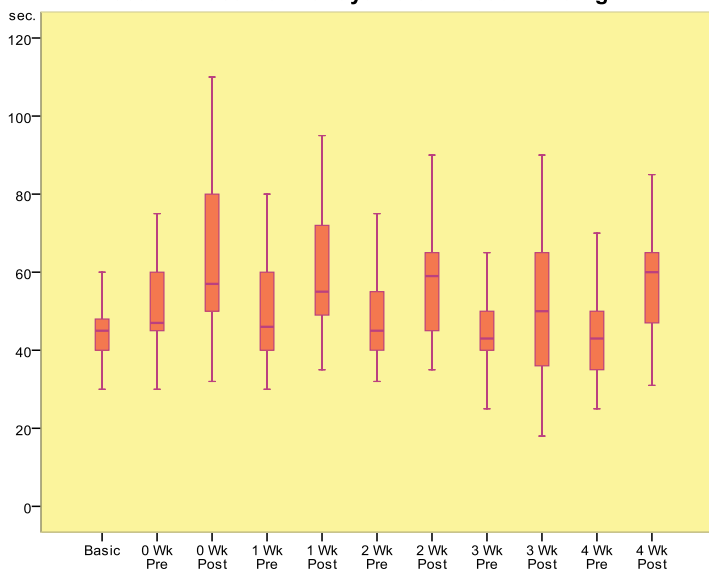
PEFR reflects the state of relaxation or contraction of the tracheo-bronchial tree. If the air passage is contracted, air will move less easily and PEFR will be low, and when it is relaxed and dilated, PEFR will rise. Also PEFR will be reduced if the respiratory muscular effort is poor. The mean PEFR (litres/minute) showed deterioration after bhastrika pranayama probably due to fatigue of the respiratory muscles. Resting values of PEFR showed improvement only once. See Table 5 and the accompanying graphs.

Table 5: Effect of bhastrika pranayama on breath-holding time and PEFR

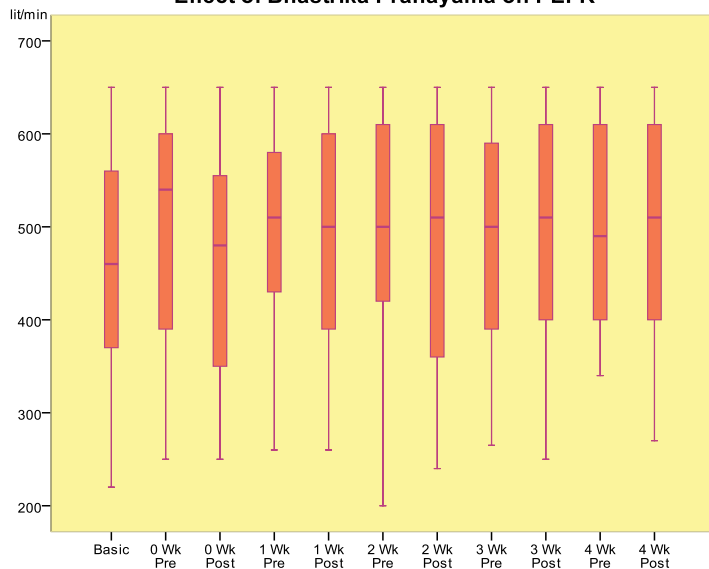
n=21	Week 0	Week 1	Week 2	Week 3	Week 4	F	Significance
BHT							
<i>Pre</i>	49.91	50.14	48.76	45.91	43.86	2.586	0.074
<i>Post</i>	63.24	59.86	58.76	51.52	57.57	3.274	0.037
<i>T Test</i>	4.341	4.291	5.089	2.322	4.661		
<i>Significance</i>	0.000	0.000	0.000	0.031	0.000		
PEFR							
<i>Pre</i>	489.05	493.81	494.29	478.10	496.67	1.110	0.384
<i>Post</i>	464.05	480.00	481.43	493.33	496.19	1.238	0.332



Effect of Bhastrika Pranayama on Breath Holding Time



Effect of Bhastrika Pranayama on PEFR



iii) **Effect on metabolism**

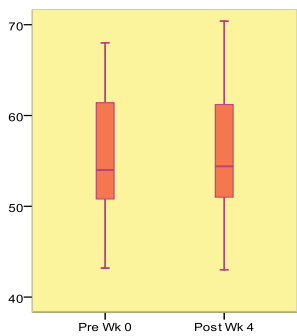
I. *Body weight*

Bhastrika pranayama is said to have a catabolic (burning of the energy resources) effect on the metabolism. Loss in body weight was expected during the practice period. We measured body weight (kg) at the beginning and at the end of the experiment. It showed no significant change. See Table 6 and the accompanying graph.

Table 6: Effect of bhastrika pranayama on body weight

n=21	Body weight	t test	Significance
Pre	56.83	0.323	0.750
Post	56.91		

kg Body Weight in Bhastrika

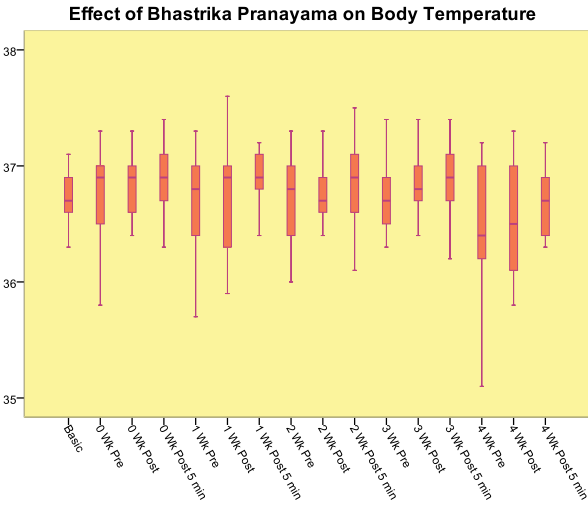
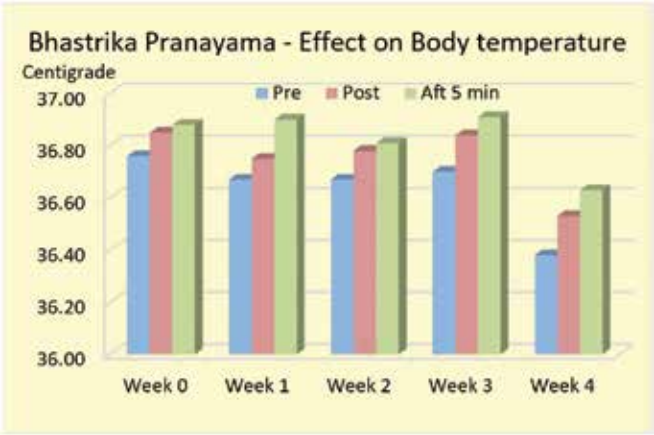


II. *Body temperature*

Bhastrika pranayama is said to have a heating or catabolic influence on the body. Every week we measured body temperature before, just after and 5 minutes after the practice of bhastrika pranayama. It showed a rise in body temperature by about 0.1 degree Centigrade which was also maintained for further 5 minutes. The progressive resting values of body temperature showed no changes indicating a temporary stimulating effect on the metabolism. See Table 7 and the accompanying graphs.

Table 7: Effect of bhastrika pranayama on body temperature

n=21	Week 0	Week 1	Week 2	Week 3	Week 4
Pre	36.76	36.67	36.67	36.70	36.38
Post	36.85	36.75	36.78	36.84	36.53
After 5 min	36.88	36.90	36.81	36.91	36.63



iv) Pranic experiences

I. *Effect on swara*

Bhastrika pranayama is a stimulating pranayama. One could expect the right nostril to flow predominantly. Predominance of right-sided swara in the breathing pattern signifies pingala nadi stimulation, increased physical activity, activation of pranic energy or solar energy and alertness or excitement.

The subjects studied the pattern of swara before, just after and 5 minutes after the practice daily by self-observation and reporting in a diary. The frequency of dominance of relevant swara is tabulated in Table 8. It showed conversion from ida or left swara predominance to sushumna or balanced swara and at times to pingala or right swara predominance.

Table 8: Swara pattern in bhastrika pranayama

n=21	Pre			Post		
	Right	Left	Both	Right	Left	Both
Week 0	9	10	2	8	5	8
Week 1	6	13	2	11	3	7
Week 2	3	14	4	9	5	7
Week 3	2	14	5	7	4	9
Week 4	10	9	2	7	7	7

II. *Awareness of chakra*

Every yoga practice stimulates one or more chakras, the centres of concentrated prana situated in the vertebral column in the subtle body. All throughout the experiment each subject maintained a diary of sensations experienced, their location and intensity. Intensity of each experience was graded 1 to 5 and readings were added up for one week.

Pranic experiences were most commonly experienced at manipura chakra (average about 6 days a week, with frequency decreasing a little with time) followed by ajna and anahata (average 4.5–5 and 4–4.5 days a week respectively

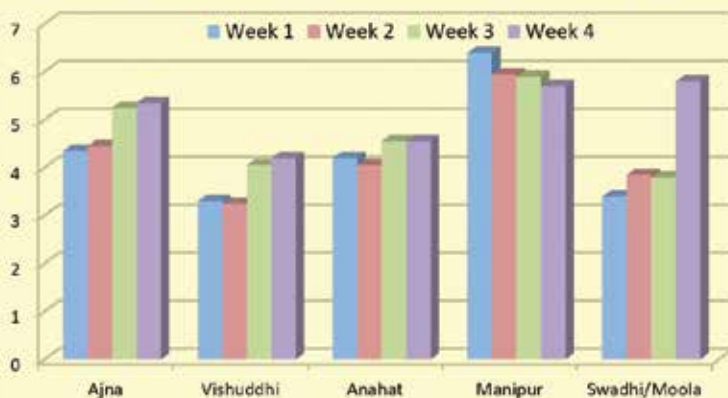
and with frequency increasing with time). The vishuddhi and the combined swadhisthana/mooladhara experience were not common (average 3–3.5 days a week). Combined awareness of swadhisthana/mooladhara jumped sharply to 5.8 days per week in week 4 due to the practice of maha bandha. The intensity of the experience followed the pattern of frequency. It was highest in the manipura area followed by ajna, anahata, vishuddhi and swadhisthana/mooladhara in that order. The intensity suddenly rose to a peak in mooladhara and vishuddhi in week 4 due to maha bandha. See Table 9. These findings confirm that bhastrika pranayama stimulates manipura chakra. Nasagra mudra helps in stimulating ajna chakra. Jalandhara bandha directly stimulates vishuddhi and moola bandha stimulates mooladhara chakra.

Table 9: Frequency & intensity of pranic experience at different chakras in bhastrika pranayama: mean values

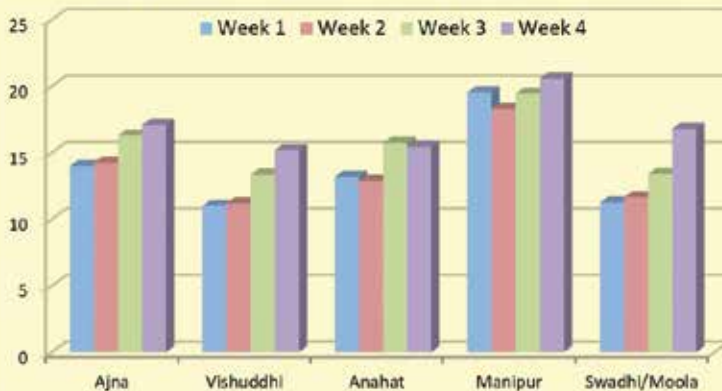
	Frequency			
	Week 1	Week 2	Week 3	Week 4
<i>Ajna</i>	4.35	4.45	5.25	5.35
<i>Vishuddhi</i>	3.30	3.25	4.05	4.20
<i>Anahata</i>	4.20	4.05	4.55	4.55
<i>Manipura</i>	6.40	5.95	5.90	5.70
<i>Swadhi/Moola</i>	3.40	3.85	3.80	5.80

	Intensity			
	Week 1	Week 2	Week 3	Week 4
<i>Ajna</i>	14	14.25	16.3	17.1
<i>Vishuddhi</i>	11	11.2	13.35	15.2
<i>Anahata</i>	13.2	12.9	15.75	15.45
<i>Manipura</i>	19.55	18.3	19.45	20.6
<i>Swadhi/Moola</i>	11.25	11.65	13.4	16.8

Bhastrika Pranayama - Frequency of Pranic Experience



Bhastrika Pranayama - Intensity of Pranic Experience



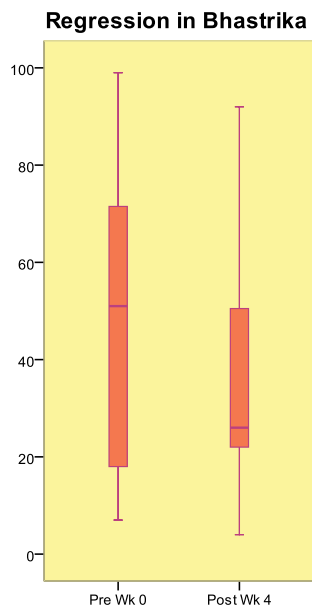
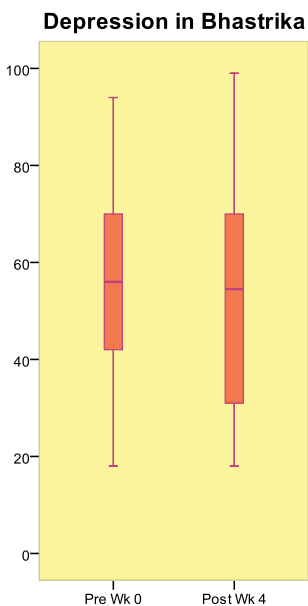
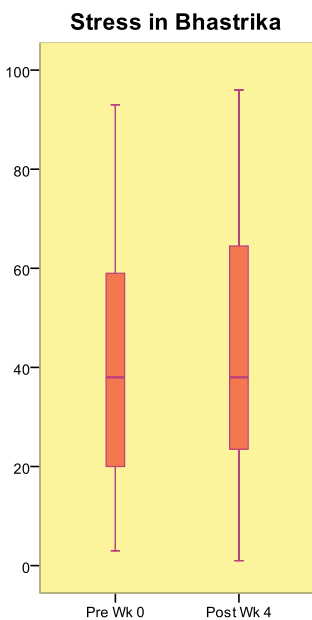
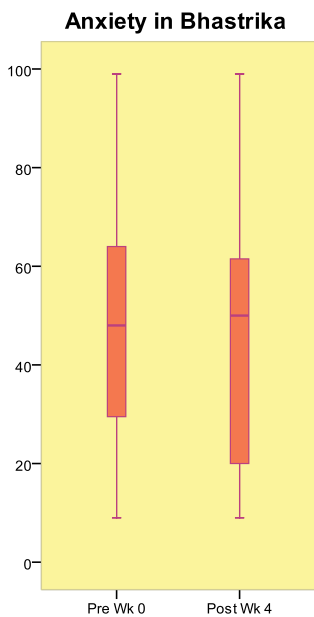
v) Psychological experiences

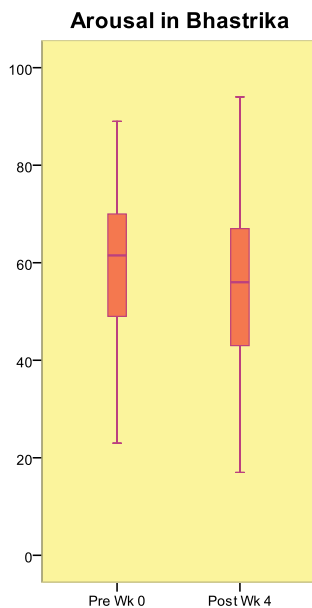
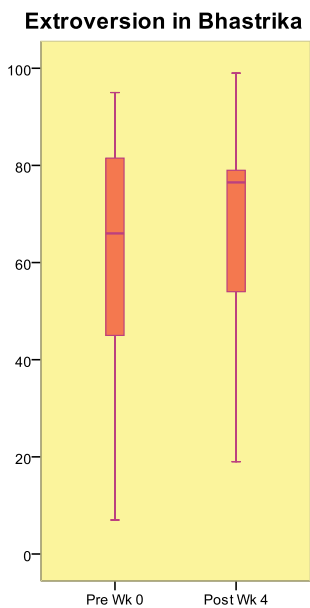
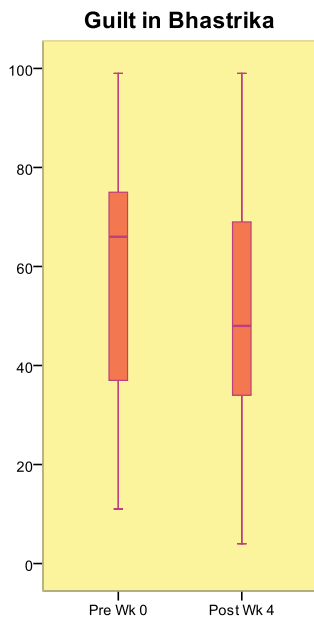
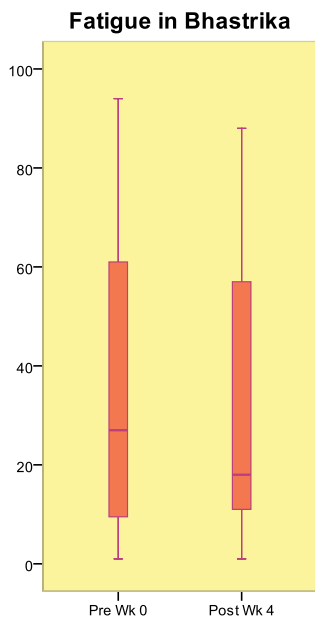
I. State of mood

The state of mood was measured in the beginning and at the end of the experiment using Eight States Questionnaire (8 SQ). The test measures eight different states of moods: anxiety, stress, depression, regression, fatigue, guilt, extroversion and arousal. Some individuals expressed change in their mood states; but except for the dimensions of regression and guilt we did not find any overall significant change in different mood states after 5 weeks of regular bhastrika pranayama practice. See Table 10 and the accompanying graphs.

Table 10: Effect of bhastrika pranayama on state of mood (in percentile)

	Mean		Std dev		t test	Significance
	Pre	Post	Pre	Post		
<i>Anxiety</i>	50.05	46.25	26.33	28.38	0.847	0.407
<i>Stress</i>	26.33	28.38	28.63	27.46	0.483	0.634
<i>Depression</i>	55.75	52.95	21.59	24.01	0.627	0.538
<i>Regression</i>	49.3	37.5	29.72	26.13	2.554	0.019
<i>Fatigue</i>	34.9	31.85	28.57	28.18	0.539	0.596
<i>Guilt</i>	58.9	50.8	25.36	24.12	2.149	0.045
<i>Extroversion</i>	60.55	65.8	26.73	26.18	1.020	0.320
<i>Arousal</i>	57.7	54.9	19.04	19.99	0.558	0.583





II. *State of mind and state of energy*

The subjects also maintained a diary stating their energy level, mental states of peace, alertness and mood (happiness to sadness). It was reported on a scale of 1 to 5 on a daily basis, 3 being the neutral or normal state. The weekly reading was the total of all seven days. The immediate effect on happy-sad mood was marginal but statistically significant in week 3 and 4. The level of alertness improved to a small degree but statistically significant in week 1 and 2. The improvement was more in week 3 and 4. The feeling of peace improved marginally in all weeks but more so in week 3 and 4. It was statistically significant in week 3 and 4. The energy level also improved marginally throughout, but statistically significant only in week 2 and 3. See Table 11 and the accompanying graphs.

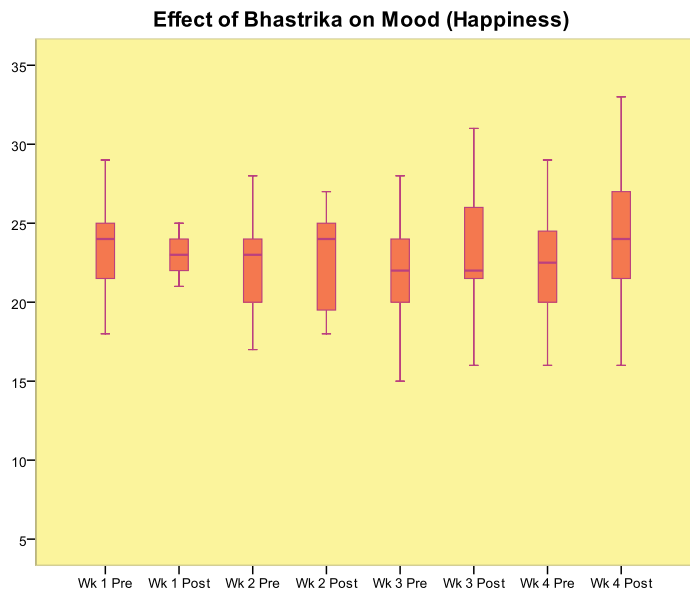
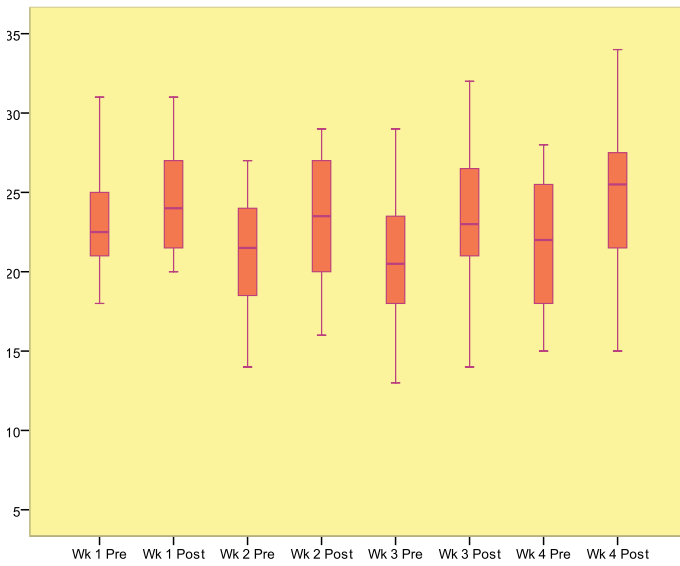


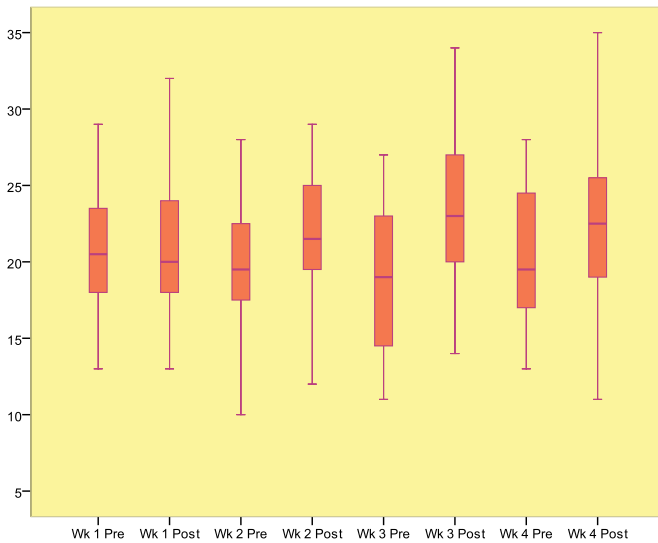
Table 11: Effects of bhastrika pranayama on states of mind & energy

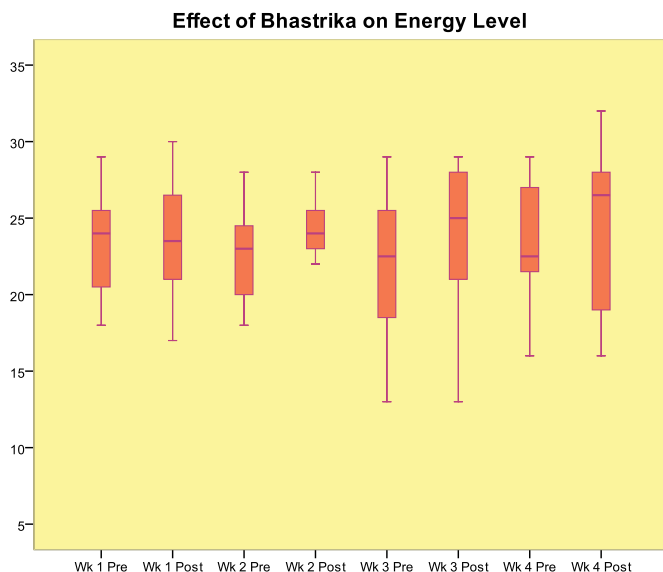
	Week 1			Week 2			Week 3			Week 4		
	Pre	Post	t/signi	Pre	Post	t/signi	Pre	Post	t/signi	Pre	Post	t/signi
<i>Happiness</i>	23.6	23.00	0.922	21.6	22.00	0.619	21.8	23.3	1.783	22.7	24	2.041
			0.368			0.543			0.091			0.055
<i>Alertness</i>	22.95	24.2	2.173	21.05	22.85	2.308	20.5	23	3.052	21.65	24.3	3.141
			0.043			0.032			0.007			0.005
<i>Peacefulness</i>	20.65	21	0.560	19.65	20.95	1.366	19.2	23.3	4.541	20.5	22.55	2.664
			0.582			0.188			0.000			0.015
<i>Energy level</i>	23.45	23.75	0.516	21.8	23.15	2.145	21.65	23.35	2.184	23.45	24.65	1.494
			0.611			0.045			0.042			0.152

Effect of Bhastrika on Alertness



Effect of Bhastrika on Sense of Peace





vi) Subjective observations

The subjects maintained a weekly diary observing the general effects on their systems of body, mind, energy and emotions. Only 3 areas showed meaningful effects. The **appetite improved** in 9 out of 20 subjects. A high number of subjects reported **signs of more heat production** like a warmer body or heat rash, pimples and boils. One subject had persistent fever without any medical cause which subsided once the practice was stopped for a couple of days. **The effect on emotional responses** was significant. Emotional responses were exaggerated in 5 subjects, 2 had irritability and anger, one felt unstable while 4 subjects felt balanced. The rest of all findings were equivocal. The production of mucus in the respiratory passages was decreased in 3 subjects while 7 continued having mucus. The digestion improved in 6 subjects but 6 had acidity and mouth ulcers, and 8 had gas and indigestion. Two subjects were constipated and 3 had loose motion; 8 had irregular bowel movement, while 2 showed improved regularity. Two

subjects reported more relaxed muscles, one found them tense, 1 subject felt hyperactive. The duration of sleep increased in 2 and decreased in 2 subjects. The quality of sleep improved in 3 while 5 subjects experienced disturbed sleep. Five subjects felt high energy levels, 1 felt low and 3 felt fluctuating levels. The state of mind varied a lot – 6 subjects had a focused or concentrated mind, 6 a dissipated and 6 a tense mind. 6 subjects felt increased clarity, 2 felt relaxed, 2 felt balanced. Interest in sense enjoyment increased in 5 and decreased in 6 subjects. Passion and sexual arousal increased in 2 and decreased in 2 subjects. See Table 12.

Table 12: Summary of subjective effects of bhastrika pranayama

Dimension	Remark
<i>Respiratory passage</i>	Mucus: 7; decrease in mucus: 3. kevala kumbhak during practice: 3
<i>Appetite</i>	Increased: 9; decreased: 2
<i>Digestion</i>	Improved: 6; deteriorated: 1; acidity: 4; gas: 7; mouth ulcer: 2
<i>Bowels</i>	Constipation: 2; irregular: 8; loose motion: 3; improved: 2
<i>Muscles</i>	Relaxed: 2; tense: 1; hyperactivity: 1
<i>Skin</i>	Heat in abdomen during practice: 4; warm body: 3; persistent evening fever without cause: 1; stopped after temporary cessation of practice; heat rash: 2; pimples: 3; boil: 2; improved complexion: 1
<i>Sleep duration</i>	Increased: 2; decreased: 2
<i>Sleep quality</i>	Disturbed: 5; improved: 2; deep: 1
<i>Energy state</i>	Fluctuating: 3; low: 1; high: 5

Dimension	Remark
<i>Mental state</i>	Focused/concentrated: 6; dissipated: 6; tense: 6; increased internalization in practice: 2; balanced: 2; relaxed: 2; increased clarity: 6; intuitive: 1; elevated mood: 1; fluctuating mood: 1
<i>Emotional responses</i>	Increased: 5; unstable: 1; irritability & anger: 2; settling: 1; balanced: 3
<i>Sense enjoyment</i>	Increased: 5; decreased: 6
<i>Sexual arousal</i>	Increased: 2; decreased: 2

Conclusion

- Every week systolic BP (mmHg) decreased immediately after the practice, except in week 3, when external kumbhaka was introduced. The readings after 5 minutes showed a tendency to rise again partially. Resting or pre-systolic BP increased marginally over 5 weeks.
- Diastolic BP (mmHg) increased negligibly immediately after the practice; except in week 3, when external kumbhaka was introduced, the rise was substantial (3.5 mmHg). The readings after 5 minutes showed a tendency to come back to pre-reading. The resting diastolic BP (pre) did not show much change.
- Every week the pulse-rate (per minute) decreased immediately after the practice and the fall either continued or was maintained at the end of a further 5 minutes. The resting pulse-rate (pre) showed a tendency to rise from week 2–4 indicating overall sympathetic stimulation.
- Every week the BHT (seconds) showed improvement after bhastrika pranayama. The improvement was less marked in week 3 when external kumbhaka was introduced. The progressive resting values of BHT did not show much improvement.
- The mean PEFR (litres/minute) showed deterioration after bhastrika pranayama probably due to fatigue of

respiratory muscles. Resting values of PEFR showed improvement only once.

- The body weight showed no significant change.
- The body temperature showed a rise by about 0.1 degree centigrade which was also maintained for further 5 minutes. The progressive resting values of body temperature showed no changes indicating a temporary stimulating effect on the metabolism.
- The swara pattern showed conversion from ida or left swara predominance to sushumna or balanced swara and at times to pingala or right swara predominance.
- Bhastrika pranayama stimulates manipura chakra. Nasagra mudra helps in stimulating ajna chakra. jalandhara bandha directly stimulates vishuddhi and moola bandha stimulates mooladhara chakra.
- No significant change in different mood states was found after 5 weeks of regular bhastrika pranayama practice.
- The immediate effect on happy-sad mood was marginal but statistically significant in week 3 and 4. The level of alertness improved to a small degree but was statistically significant in week 1 and 2. The improvement was more in week 3 and 4. The feeling of peace improved marginally in all weeks but more so in week 3 and 4. It was statistically significant in week 3 and 4. The energy level also improved marginally throughout, but was statistically significant only in week 2 and 3.

STUDY II

In the second phase of the study physiological changes of bhastrika pranayama were studied.

Method

In the last (4th) week of the experiment a pulse oxymetry study was carried out on each participant of Study I while they were practising 5 rounds of bhastrika pranayama with maha bandha in external kumbhaka. Pulse oxymeter is an instrument that monitors pulse-rate (beats/min) and capillary oxygen saturation (%) from moment to moment using a non-invasive finger probe. The results were very informative as it showed the effects of pranayama at every step and instantaneously. BP could not be measured simultaneously.

The pulse oxymeter measures oxygen saturation in capillary blood (SaO₂) in percent. If the respiration is not adequate due to any reason or the peripheral circulation is impaired the SaO₂ value will fall and on improvement it will reach its normal value of 100%. Only after substantial deterioration of the cardio-respiratory function will the SaO₂ value start falling.

Results and discussion

See Tables 13–15 and the accompanying graphs.

During bellows breathing the pulse-rate increased in 12 subjects out of 21, increased and then decreased in 4 persons, decreased in one and was found to be inconsistent in 4 of which one developed pulsus alternans, signifying an impaired pumping action of the heart. **Maximum increase was by 40 per minute and average was 22 per minute.** As all the subjects were healthy, their pre-value of SaO₂ was 100%. During bellows breathing it was maintained at 100% except in 2 subjects where it went to 99%. As the readings were already maximal any improvement could not be registered.

The increase in pulse-rate could be due to sympathetic stimulation. The second and more important reason is

the in-built cardiovascular reflexes. The increased depth and rate of breathing enhance venous return by creating more profound negative pressure in the chest cavity, the thoracic pump effect. To compensate this increased load of venous return the heart increases its rate and stroke volume. The increased cardiac output may contribute to rise in BP.

At the onset of external kumbhaka without bandha the pulse-rate decreased in 13 subjects out of 21, increased in 6, increased and decreased in 1 and reverted to normal rhythm in the person who had developed pulsus alternans. **Maximum decrease was by 32 per minute and average was 17.4 per minute.** There was no immediate change in SaO₂ as external kumbhaka started.

At the end of exhalation the pressure inside the chest cavity reaches its peak, the highest positive pressure, due to contraction of the respiratory muscles. This slows down the venous return to the lowest. The heart has hardly any blood to pump, so it slows down and offers itself some rest. Bellows breathing increases oxygen content of arterial blood to a very small extent in contrast to popular belief. The normal breath is sufficient to fully oxygenate the blood in healthy individuals. Bellows breathing mainly washes out carbon dioxide, CO₂, and thus suppresses the respiratory drive in brain centres. The desire or need to take the next breath is delayed until the CO₂ level in the blood builds up again over time, usually a few seconds to a minute or slightly more. This phenomenon facilitates kumbhaka.

During external kumbhaka without bandha pulse-rate further decreased in 7 persons, increased in 5, both increased and decreased in 5 and was inconsistent in 4. **Maximum decrease was by 40 per minute and average was 24.25 per min. Maximum increase was by 30 per minute and average was 15.6 per minute.** During external kumbhaka without bandha SaO₂ decreased in 13 out of 21 persons (99–95% generally, 65–81% in one subject) and in 8 persons it remained unaltered.

As the external kumbhaka continues the supply of oxygenated blood to body tissues decreases and they send an alarm to the brain to increase the blood supply. This causes the heart rate to go up. If the oxygen supply is curtailed drastically and too long, then this emergency compensation fails and the heart rate will start falling again. This can become life threatening.

On release of external kumbhaka without bandha the pulse-rate increased in 7 subjects, decreased in 4, was inconsistent in 2 and in 8 subjects data could not be collected. **Maximum increase was by 30 per minute and average 20.75 per minute. Maximum decrease was by 40 per minute and average 30 per minute.** On release of kumbhaka, SaO₂ values were restored in all subjects except 3 where the fall continued for some time. In 2 subjects it dropped to 83–81%.

As inhalation restarts, the negative pressure created in the chest cavity will improve venous return and increase the heart rate. In some subjects oxygen saturation reaches a very low level, and so in spite of better venous return they take longer to recover the heart rate as well as the stroke volume. They may even show further slowing of heart and further fall in SaO₂ for a short time.

At the onset of maha bandha in external kumbhaka the pulse-rate decreased in 9 subjects, increased in 6, remained same in 1 and in 5 subjects the data could not be collected. **Maximum decrease was by 25 per minute and average 11.4 per minute. Maximum increase was by 11 per minute and average 8 per minute.** There was no change in SaO₂ just after maha bandha.

The physiologic changes at the onset of maha bandha are the same as in the onset of external kumbhaka, but the decrease in pulse-rate was less. There are two reasons for this phenomenon. One, bandhas have a stimulatory effect on prana (sympathetic stimulation). Two, uddiyana bandha will create negative pressure in the thoracic cavity improving venous return and increasing the pulse-rate earlier. This

increase in pulse-rate partly compensates for the overall decrease. In jalandhara bandha carotid bodies are expected to be stimulated causing a more profound fall in pulse-rate, but we did not observe this phenomenon.

During maha bandha in external kumbhaka the pulse-rate further decreased in 10 subjects, increased in 4, both increased and decreased in one, inconsistent in one and in 5 subjects data could not be collected. **Maximum decrease was by 20 per minute and average 14.4 per minute. Maximum increase was by 39 per minute and average 22.25 per minute.** SaO₂ decreased in 12 subjects during maha bandha (99–92% generally and 86–69 % in 4 subjects). The decrease was greater than in the external kumbhaka stage without bandhas. Four persons did not practise maha bandha and in 5 subjects SaO₂ was maintained at 100%.

The same explanations as in external kumbhaka and maha bandha apply here for the continuing decrease in pulse-rate. The decrease in pulse-rate in external kumbhaka with maha bandha was comparatively less than the external kumbhaka without bandhas.

On release of maha bandha and resumption of breath the pulse-rate further decreased in 8 subjects, increased in 3, both increased and decreased in 2, remained the same in one, inconsistent in 3 and in 4 persons data could not be collected. **Maximum decrease was by 35 per minute and average 20.8 per minute. Maximum increase was by 25 per minute and average 19.7 per minute. On release of maha bandha the decrease in SaO₂ continued for some time to quite an extent (99–87 % generally and 81–54% in 6 subjects).**

In contrast to the release of external kumbhaka, the release of maha bandha further decreased the heart rate because the subjects were able to hold the breath out for a longer time and tolerated much lower saturation of oxygen in the peripheral blood. Their centres for vital function in the brain took longer to recover their normal function. Physiologically it is not a sound condition but for a yogi it is

advantageous because he can tolerate hypoxia longer and better. So his kumbhaka is sustained for longer periods and his chance of experiencing a transcendental state is better.

Table 13: Effect of different stages of bhastrika pranayama on pulse-rate & oxygen saturation

Event	Change in pulse-rate			Change in SaO2	
	<i>Trend</i>	<i>Average</i>	<i>Maxim change</i>	<i>Trend</i>	<i>Min</i>
<i>Bellows breathing</i>	Increase	Up 22/min	Up 40/min	No change	100 %
<i>Ext. kumbhaka: onset</i>	Decrease	Down 17.4/min	Down 32/min	No change	100 %
<i>Ext. kumbhaka: during</i>	Both up & down	Down 24.25/min; up 15.6/min	Down 40/min; up 30/min	Decrease	65 %
<i>Ext. kumbhaka: release</i>	Increase	Up 20.75/min; down 30/min	Up 30/min; down 40/min	Increase	100 %
<i>Maha bandha: onset</i>	Decrease	Down 11.4/min; up 8/min	Down 25/min; up 11/min	No change	100 %
<i>Maha bandha: during</i>	Decrease	Down 14.4/min; up 22.25/min	Down 20/min; up 39/min	Decrease	69 %
<i>Maha bandha: release</i>	Decrease	Down 20.8/min; up 19.7/min	Down 35/min; up 25/min	Decrease	54 %

Table 14: Effect of different stages of bhastrika pranayama on change in pulse-rate from base value

	Mean	Std dev	25 percentile	50 percentile	75 percentile	Range
<i>Bhastrika</i>	21.38	8.48	15.00	20.00	25.00	10-40
<i>Start kumbhaka</i>	-9.60	16.87	-17.25	-7.00	0.00	-65 to +13
<i>Kumbhaka</i>	-7.14	22.29	-30.00	0.00	10.00	-40 to +20
<i>Release kumbhaka</i>	8.50	15.29	-7.25	14.00	18.75	-14 to +20
<i>Start maha bandha</i>	-3.33	11.58	-10.00	-4.00	8.75	-25 to +11
<i>Maha bandha</i>	-2.17	20.11	-20.00	-7.50	13.50	-25 to +35
<i>Release maha bandha</i>	-11.30	20.42	-23.75	-12.50	-.75	-40 to +25

Please note that the changes in pulse-rate during various phases are very big and occur very quickly, changing moment to moment, and so may tax a weak heart to a great extent.

Table 15: Overall effect of of bhastrika pranayama on pulse-rate

	Mean	Std dev	25 percentile	50 percentile	75 percentile	Range
<i>Basic PR</i>	84.76	9.86	80.00	86.00	91.00	62–102
<i>Maximum PR</i>	116.90	14.70	104.50	115.00	128.50	95–151
<i>% Rise in PR</i>	39.20	20.22	22.47	35.87	57.73	12–81
<i>Minimum PR</i>	75.10	10.39	69.50	77.00	83.00	47–89
<i>% fall in PR</i>	11.36	8.40	5.11	12.00	18.76	-7 to +25

Table 16: Effect of different stages of bhastrika pranayama on SaO2

	Mean	Std dev	25 percentile	50 percentile	75 percentile	Range
<i>Bhastrika</i>	99.95	0.218	100.00	100.00	100.00	99–100
<i>Kumbhaka</i>	95.00	8.620	92.50	99.00	100.00	65–100
<i>Release kumbhaka</i>	96.00	7.454	93.50	100.00	100.00	81–100
<i>Maha bandha</i>	91.50	10.185	87.50	95.50	99.75	69–100
<i>Release maha bandha</i>	83.94	14.241	69.50	90.00	95.50	54–100

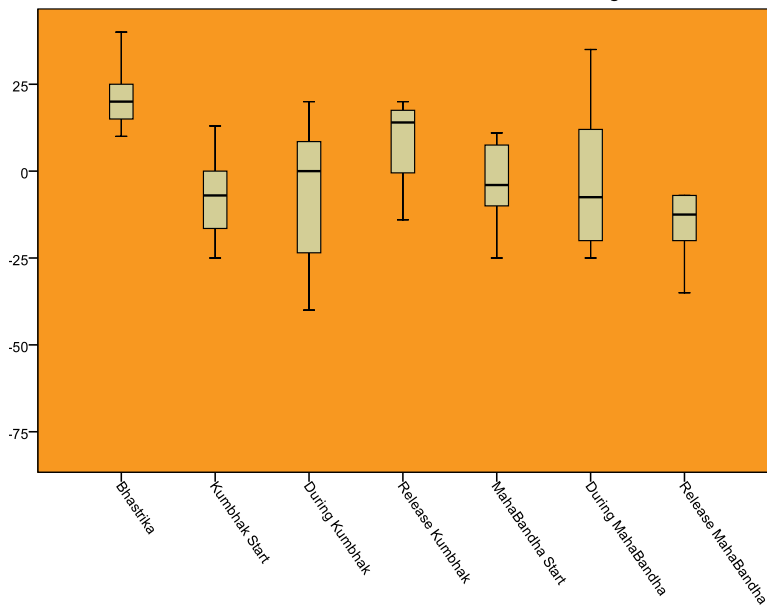
Table 17: Cardio-respiratory strain in individual subjects during bhastrika pranayama

Subject	Base pulse	Max pulse	% rise from base value	Min pulse	% fall from base value	Min SaO2	Notes
1	83	97	16.87	66	20.48	87	
2	92	125	35.87	89	3.26	98	
3	88	120	36.36	83	5.68	99	
4	80	132	65.00	81	-1.25	81	
5	86	132	53.49	77	10.47	96	sinus arrhythmia
6	85	104	22.35	79	7.06	99	
7	92	114	23.91	80	13.04	97	pulsus alternans
8	90	124	37.78	77	14.44	54	
9	71	115	61.97	76	-7.04	98	
10	88	116	31.82	84	4.55	72	
11	85	95	11.76	64	24.71	90	
12	68	101	48.53	55	19.12	91	
13	75	136	81.33	66	12.00	67	

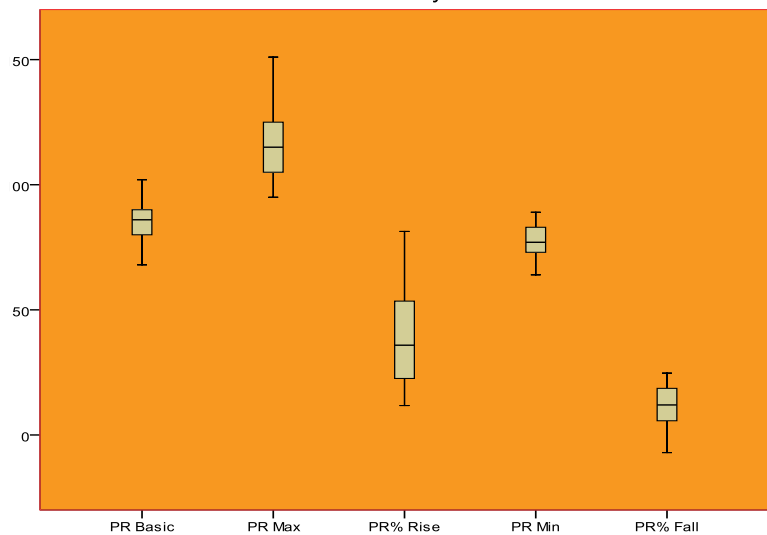
Table 17 cont.

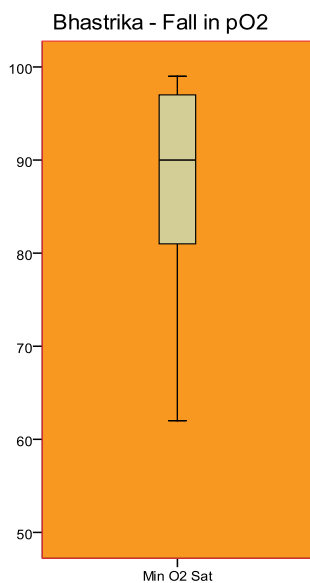
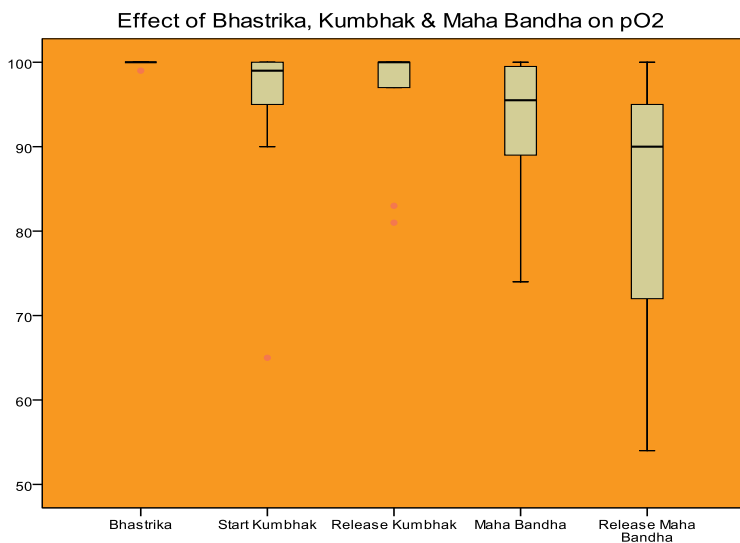
Subject	Base pulse	Max pulse	% rise from base value	Min pulse	% fall from base value	Min SaO2	Notes
14	100	118	18.00	83	17.00	81	
15	93	114	22.58	86	7.53	91	
16	62	104	67.74	47	24.19	67	
17	89	151	69.66	76	14.61	62	
18	80	109	36.25	78	2.50	98	
19	81	106	30.86	74	8.64	87	
20	102	137	34.31	83	18.63	90	
21	90	105	16.67	73	18.89	95	
Range	62~102	95~151	11.76~69.66	47~89	-7.04~24.71	54~99	
Mean	84.76	116.90	39.20	75.10	11.36	85.71	
Std dev	9.86	14.70	20.22	10.39	8.40	13.64	

Effect of Bhastrika, Kumbhak & Maha-Bandha on Change in Pulse-rate



Effect of Bhastrika Pranayama on Pulserate





Conclusion

It is evident from these tables that the demand on the heart and on the process of oxygen supply is considerable. Mean rise in pulse-rate is 32 per min or 39% of the resting value and mean drop in peripheral oxygen saturation is about 15%. A person with heart, circulatory, respiratory and brain disorders may not tolerate these wide fluctuations in pulse-rate and oxygen saturation in the blood. Similarly, when an organ is damaged, the fall in oxygen supply can further deteriorate its functioning, for example kidneys and eyes.

Psychophysiological Effects of Nadi Shodhana Pranayama, 2001–2002

Nadi shodhana pranayama is the most commonly practised pranayama. It is suitable for most people. It is practised in different stages and different ratios of inhalation to exhalation. As the name, purification of *nadis*, the psychic pathways, suggests this pranayama clears the obstructions to the flow of prana in various nadis and thereby purifies them. It is absolutely essential to prepare the body-prana-mind complex to the optimum level before one embarks upon the higher yogic practices of self-realization or increasing one's inner potentials. This preparation includes purification of the body of various dietary and metabolic waste products and the mind of various impurities such as *mala*, in the form of six enemies (passion, anger, pride/vanity, delusion, jealousy and greed), *vikshepa*, the oscillating nature of the mind and *avarana*, the veil of wrong understanding due to five afflictions (lack of knowledge, I-ness, attachment, repulsion and fear of loss). This is stated in the *Hatha Yoga Pradipika* (2:5):

When all the nadis and chakras which are full of impurities are purified, then the yogi is able to retain prana.

The *Gheranda Samhita* states (5:32):

On a seat of kusha grass, or deer skin, or tiger skin or a blanket, facing east or north, pranayama should be practised after purifying the nadis.

In both raja yoga as well as hatha yoga pranayama practices always precede the meditation practices. This implies that every yoga aspirant has to practise and perfect nadi shodhana pranayama sometime during the journey on the path of yoga. Some of the other important purifying

practices are the shatkarmas and yama-niyamas. *Gheranda Samhita* describes two methods of purifying the nadis. The first one is called *samanu* where a beeja mantra is used. Nadi shodhana pranayama falls under this category. The second method is *nirmanu* where there is no use of mantra. Shatkarmas fall under this category. The *Hatha Yoga Pradipika* recommends that all the pranayamas are to be practised with a sattwic mind (2:6):

Therefore pranayama should be done daily with a sattwic state of mind so that the impurities are driven out of sushumna nadi and purification occurs.

What causes the blockages in the nadis?

When a yoga aspirant knowingly or unknowingly misuses the body-mind apparatus for a considerable period of time, the three doshas, *kapha*, *vata* and *pitta*, become deranged, blocking the free flow of prana in the nadis. The impurities that block the nadis are the waste and residue of sensuous living and desires. Situations that lead to blockages in the nadis are:

1. Lack of adequate physical movements;
2. Wrong posture;
3. Excessive accumulation of products of metabolism/waste products; example: gout;
4. Wrong diet and the products of digestion; example: acidic diet;
5. Pooling of prana in one area depriving the other areas; example: exercising an activity which demands intense and prolonged mental activities or only a set pattern of posture/movement;
6. Wrong lifestyle, misuse of body-mind apparatus leading to accumulation of toxic products; example: inadequate sleep, intense physical activity just after food, failure to synchronize with nature's rhythms;
7. Mental impurities as described above;
8. Excessive or wrongly timed mental or sexual activities;
9. Direct intake of toxins; example: addictive substances.

What are the signs of purification?

Signs of purification are the same as the signs of balance in the three doshas. Symptoms of physical disorders/diseases disappear and there is a feeling of lightness in the body as well as the mind. Excessive fat and mucus disappear (*kapha*), stability and firmness in the body as well as the mind become noticeable (*vata*) and the internal organs, especially the digestive system, and the intellect start functioning efficiently (*pitta*). The urge to eat becomes less, the excretory processes function regularly and efficiently, the voice becomes deeper, steadier and sweeter, the need for sleep reduces and the quality of thoughts and meditation improves. In the *Hatha Yoga Pradipika* it is said (2:19–20):

When the nadis are purified, there are external symptoms.

Success is definite when the body becomes thin and glows.

When one is able to hold the vayu according to one's will, the digestive power increases.

With the nadis purified, thus the inner sound or nada awakens and one is free from disease.

Nadi shodhana pranayama is one of the most 'required' practices on the path of yoga and because of its various stages and ratios of duration of inhalation to exhalation; it is also suitable for most people. Keeping this in mind YRF undertook a research project to study some of the basic psychophysiological effects of nadi shodhana pranayama on 22 sannyasa course students of the Bihar School of Yoga, in the year 2002 (January to June). We present here the research report of the study.

Hypotheses

Regular practice of nadi shodhana pranayama will:

1. increase Breath Holding Time (BHT) and Peak Expiratory Flow Rate (PEFR);

2. normalize pulse-rate (PR), Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) and set them at a reduced normal value;
3. improve short-term numerical and long-term memory;
4. increase the speed of performing repetitive mathematical tasks;
5. balance the swara;
6. stimulate ajna and mooladhara chakras.

Research design

Progressive, repeated measure, uncontrolled trial.

SPSS 17 software was used to calculate F statistics to prove the hypotheses.

Sample

The sample consisted of 22 sannyasa course students of the Bihar School of Yoga, Ganga Darshan, Munger, from July 2001 to July 2002. There were 10 females and 12 males within the age range of 19 to 62 years (mean=31.5, median=29), only 4 subjects were older than 35 years. None had any major systemic medical problem. They were mainly students by profession.

Parameters

The following parameters were used:

1. Breath Holding Time after deep inhalation (BHT) in seconds using a watch. 5 readings
2. Peak Expiratory Flow Rate (PEFR) in litres per minute using a PEFR meter. 5 readings
3. Pulse-rate (PR) per minute using an electronic measuring device. 11 readings
4. Systolic Blood Pressure (SBP) in mm of Hg using an electronic measuring device. 11 readings
5. Diastolic Blood Pressure (DBP) in mm of Hg using an electronic measuring device. 11 readings
6. Short-term numerical memory. 2 readings

A set of two-digit numbers was shown for 10 seconds using an overhead projector and when the transparency was removed, the subjects were asked to immediately write the numbers down. The first set had one number; the second had two numbers and so on until the ninth set had a combination of nine numbers. If all the numbers were correctly written and in correct sequence, then only it was scored correct. Maximum score allowed was 9.

7. Long-term memory. 2 readings

A set of six questions was asked that required the subjects to retrieve information from the incidences that occurred at least one month before. Maximum score allowed was 6.

8. Coefficient of mental fatigue using Mental Fatigue test. 2 readings

This test consisted of a column of one digit numbers. The first number was multiplied with the second number and the answer was noted down. The last digit of the answer was then multiplied with the third number, and so on. If the last digit of the answer was 0 then it was considered as 1 in order to continue the process. The test was administered for 30 minutes continuously. After every 2 minutes the subject was asked to underline the last answer. At the end of 10 and 20 minutes it was underlined twice. The coefficient of mental fatigue was calculated by the following formula.

$(X-Y) \times 100/X$, where X=number of correct answers in the first 6 minutes; and Y=number of correct answers in the last 6 minutes.

9. Speed and proficiency in repetitive mathematical tasks using Mental Fatigue test. 2 readings

In this test, the number of correct answers in the last 6 minutes was taken as the score of speed and proficiency.

10. Occurrence of balanced swara (sushumna) after the practice was studied by checking the dominant nostril and maintaining a daily diary during the two one-month periods of 10:10 and 10:20 count practice of nadi shodhana pranayama.

11. Pranic experiences at either ajna or mooladhara during or just after the practice were studied by maintaining a daily diary during the two one-month periods of 10:10 and 10:20 count practice of nadi shodhana pranayama.

The various parameters were studied before the start and at the end of the study and during different phases of the study namely:

1. Pre-pranayama. Before starting regular pranayama practice.
2. Pre 1:1 ratio. On achieving count of 10 in inhalation and count of 10 in exhalation (10:10)
3. Post 1:1 ratio. At the end of one month of practice of 10 rounds to the count of 10:10
4. Pre 1:2 ratio. On achieving count of 10 in inhalation and count of 20 in exhalation (10:20)
5. Post 1:2 ratio. At the end of one month of practice of 10 rounds to the count of 10:20

Some parameters were collected before and after the practice of 10 rounds of pranayama at each data collection time and one resting time reading was also taken to serve as a baseline reading, thus making a total of 11 readings. See Table 1.

Duration of study

January to June 2002

Method of study

The subjects were briefed in detail about the research project. After the collection of pre readings of the psychological parameters and resting values of pulse-rate and BP, the subjects were given an explanation and demonstration of the practice of nadi shodhana pranayama stage I for three days. The following day, pre-pranayama readings were taken for BHT, PEFr, PR, SBP and DBP before and after 10 rounds of nadi shodhana pranayama stage I. A regular training class in nadi shodhana pranayama was started for the subjects on a daily basis for five working days a week.

Table 1: Flow chart for data collection

At rest	Pre-pranayama		Pre 1:1		Post 1:1		Pre 1:2		Post 1:2	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
<i>BHT + PEFR</i>	#		#		#		#		#	
<i>Pulse + BP</i>	#		#		#		#		#	
<i>All psycho tests</i>	#									
<i>Swara + personal experiences</i>					#				#	

As and when a subject reached the count of 10:10, he/she reported for data collection and pre 1:1 readings were collected. The subject was then asked to continue with the practice of 10 rounds of pranayama using the same count. He/she was asked to fill a questionnaire regarding the experience of the practice on a daily basis maintaining a diary. After one month the subject reported for data collection for post 1:1 readings.

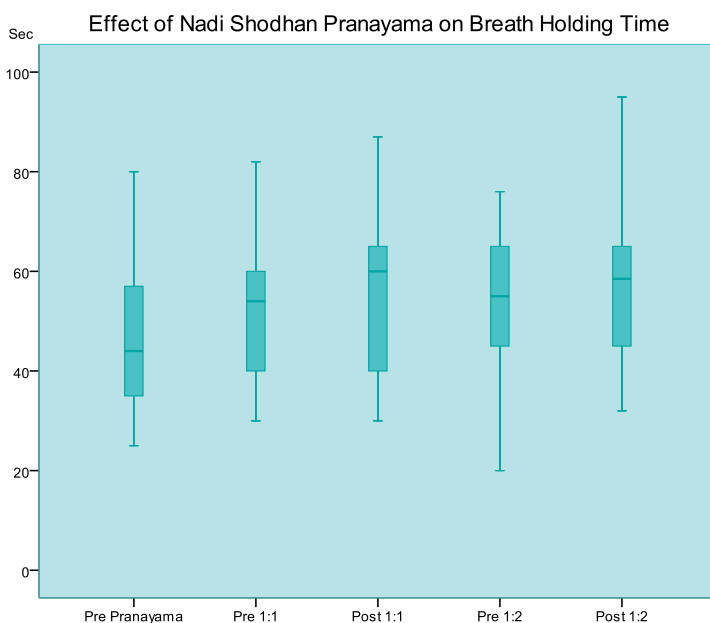
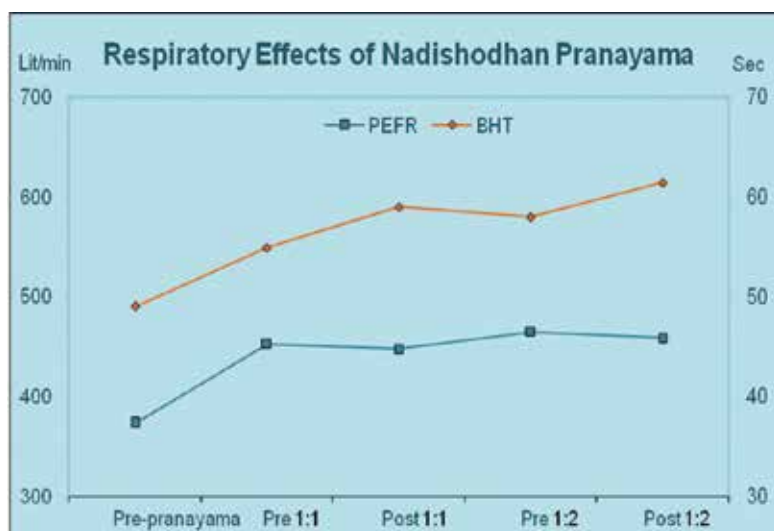
After the data collection he/she was requested to switch over to 5:10 count and gradually build the count to 10:20. On reaching the count of 10:20 he/she reported for data collection and pre 1:2 readings were collected. The subject was then asked to continue with the practice of 10 rounds of pranayama using the same count. He/she was asked to fill out a questionnaire regarding his/her experience of the practice on a daily basis as before. After one month the subject reported for data collection for post 1:2 readings. This marked the end of the study and the psychological tests were repeated to obtain the post readings. The whole study took between 4 1/2 to 6 months.

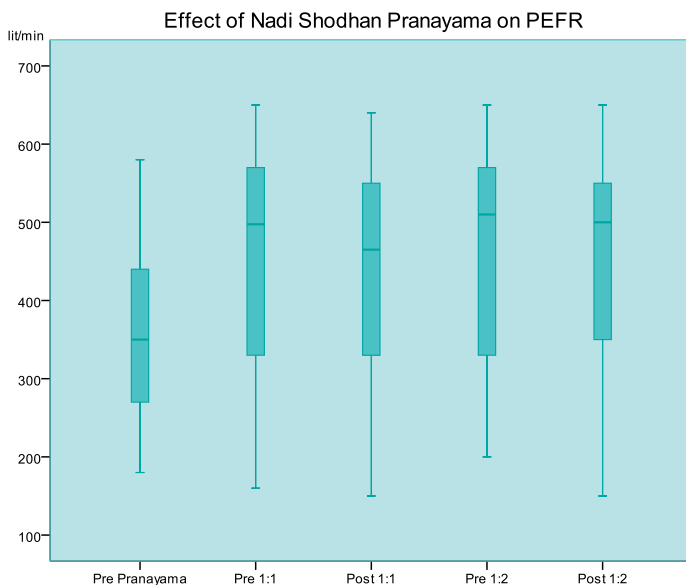
Results and discussion

Four physiologic parameters were measured to study the effects on the cardiovascular and respiratory systems. Breath holding time (BHT) showed improvement throughout but in the early phases, that of preparation and one month of 10 rounds of 10:10 count, it was greater and in later phases of preparation for and during 10 rounds of 10:20 count it was minimal. The overall improvement in BHT was highly significant ($F\ 5.704$, significance 0.000). The peak expiratory flow rate (PEFR) showed parallel improvement; improving throughout but more so in the early phases and minimal in the later phases. The overall improvement in PEFR was highly significant ($F\ 7.373$, significance 0.000). See Table 2 and accompanying graphs.

Table 2: BHT & PEFR in various stages of nadi shodhana pranayama

n=22	Mean	Std dev	F	Significance	25 percentile	50 percentile	75 percentile
BHT							
<i>Pre-pranayama</i>	49.00	21.99	5.704	0.000	35.00	44.00	57.75
<i>Pre 1:1</i>	54.91	22.78			40.00	54.00	61.25
<i>Post 1:1</i>	59.00	28.14			40.00	60.00	65.00
<i>Pre 1:2</i>	58.00	27.85			43.75	55.00	65.50
<i>Post 1:2</i>	61.45	25.83			45.00	58.50	66.25
PEFR							
<i>Pre-pranayama</i>	373.18	122.84	7.373	0.000	270.00	350.00	465.00
<i>Pre 1:1</i>	452.73	146.85			327.50	497.50	577.50
<i>Post 1:1</i>	447.73	129.80			327.50	465.00	555.00
<i>Pre 1:2</i>	465.00	149.72			317.50	510.00	577.50
<i>Post 1:2</i>	458.64	139.60			340.00	500.00	555.00





Systolic blood pressure (SBP), diastolic blood pressure (DBP) and pulse-rate (PR) remained within the normal limit throughout the experiment.

During the initial training phase SBP showed a trend to increase until the end of the 1:1 ratio phase. With the start of the 1:2 ratio phase it started coming down and by the end of the 1:2 ratio phase it reached pre-pranayama level. The rise in SBP over different stages of nadi shodhana pranayama was significant in relation to all pre practice data as well as all post practice data (Pre- F 2.4, significance 0.056 & Post- F 3.325, significance 0.014). The immediate effect of the practice was a less than significant reduction in SBP, a parasympathetic effect (F 0.576, significance 0.680). It was more pronounced during the 1:2 ratio phase than the 1:1 ratio phase. See Table 3 and the accompanying graphs.

The DBP showed very little change throughout the experiment. The change in DBP over different stages of nadi shodhana pranayama was insignificant in relation to

all pre practice data as well as all post practice data (Pre- F 0.576, significance 0.816 & Post- F 1.394, significance 0.243). The immediate practice effect showed a very small, insignificant rise in DBP (F 1.135, significance 0.342) except in the beginning of the 1:2 ratio phase (Pre 1:2) there was reduction in DBP. See Table 3 and the accompanying graphs.

Like SBP the pulse-rate increased and remained so until the end of the 1:1 ratio phase. With the start of the 1:2 ratio phase it started coming down until at the end of the 1:2 ratio phase, it reached pre pranayama level. The changes in PR over different stages of nadi shodhana pranayama were significant in relation to all pre practice data as well as all post practice data (Pre- F 5.246, significance 0.001 & Post- F 4.682, significance 0.002). There was no significant immediate practice effect during any phase of the practice (F 0.370, significance 0.830). See Table 3 and the accompanying graphs.

The overall CVS effect showed small stimulation during early phases as the subjects were trying to achieve a predetermined pattern of breathing. However, as their bodies became adjusted to this pattern, the values returned to their baseline indicating balance within the ANS.

Table 3: CVS effects of various stages of nadi shodhana pranayama

n=22	Mean	Std dev	F	Significance	25 percentile	50 percentile	75 percentile
Systolic BP							
<i>Pre-pranayama pre</i>	116.59	13.44	0.576	0.680	107.25	119.00	126.75
<i>Pre-pranayama post</i>	113.36	14.10	(immediate effect of practice)		103.50	110.50	124.50
<i>Pre 1:1 pre</i>	123.73	10.26			117.00	123.50	127.25
<i>Pre 1:1 post</i>	121.23	10.70	2.400	0.056	113.00	121.00	126.00
<i>Post 1:1 pre</i>	120.64	9.45	(effect on 'pre' levels over diff. stages of practice)		114.50	119.50	129.00
<i>Post 1:1 post</i>	116.23	9.32			109.75	116.50	121.25
<i>Pre 1:2 pre</i>	119.41	10.02			113.25	119.00	126.25
<i>Pre 1:2 post</i>	113.41	11.54	3.325	0.014	107.00	112.00	119.50
<i>Post 1:2 pre</i>	118.59	8.86	(effect on 'post' levels over diff. stages of practice)		111.25	120.50	123.00
<i>Post 1:2 post</i>	117.55	8.80			113.50	118.50	123.25

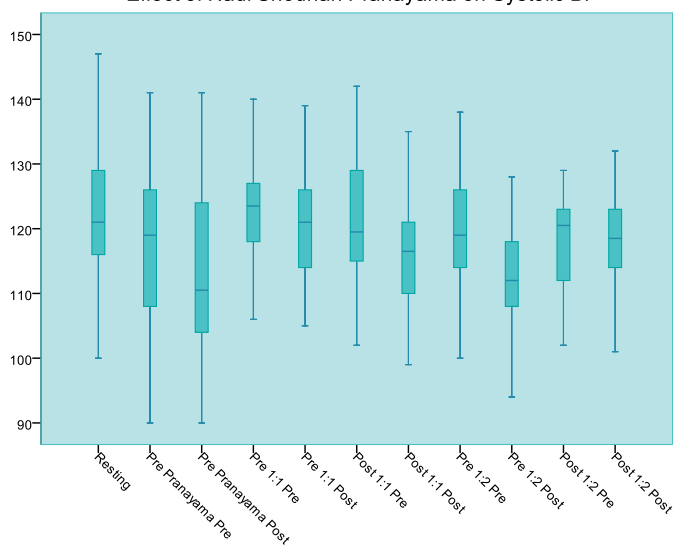
Table 3 cont.

n=22	Mean	Std dev	F	Significance	25 percentile	50 percentile	75 percentile
Diastolic BP							
Pre-pranayama pre	76.68	11.12	1.135	0.342	70.00	75.00	85.00
Pre-pranayama post	78.05	10.67	(immediate effect of practice)			78.00	85.25
Pre 1:1 pre	78.95	8.81			72.25	78.50	86.25
Pre 1:1 post	79.45	5.88	0.576	0.681	75.50	80.00	84.00
Post 1:1 pre	77.64	11.25	(effect on 'pre' levels over diff. stages of practice)		67.75	76.50	85.75
Post 1:1 post	77.00	9.10			69.75	77.50	81.75
Pre 1:2 pre	78.91	8.90			71.75	76.50	84.00
Pre 1:2 post	75.73	9.57	1.394	0.243	69.00	77.50	82.25
Post 1:2 pre	76.27	5.45	(effect on 'post' levels over)		72.50	74.50	81.25
Post 1:2 post	78.86	4.98	diff. stages of practice)		73.75	79.00	83.00

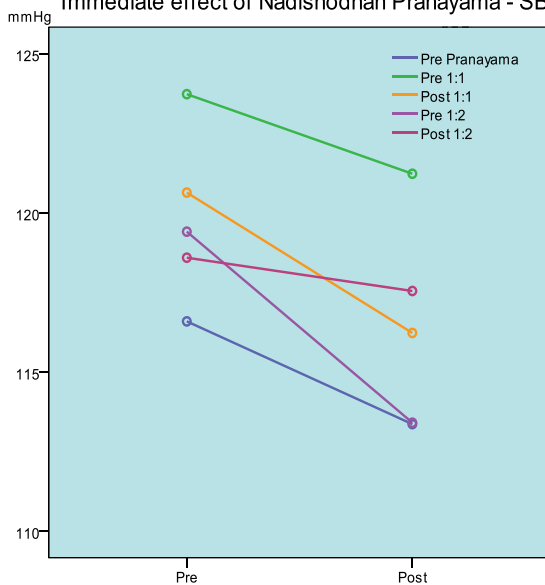
Table 3 cont.

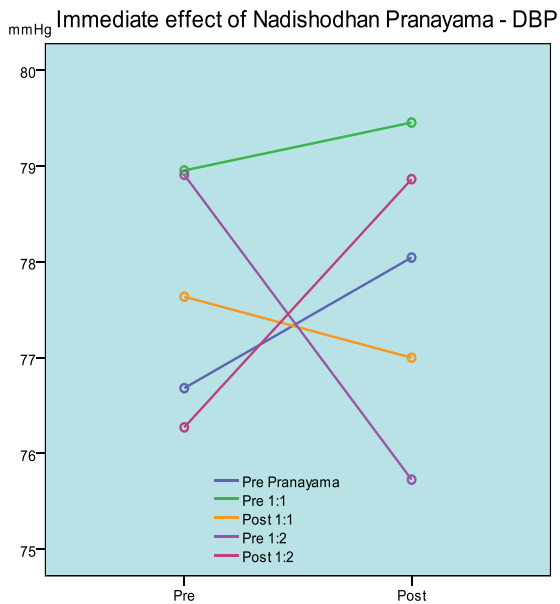
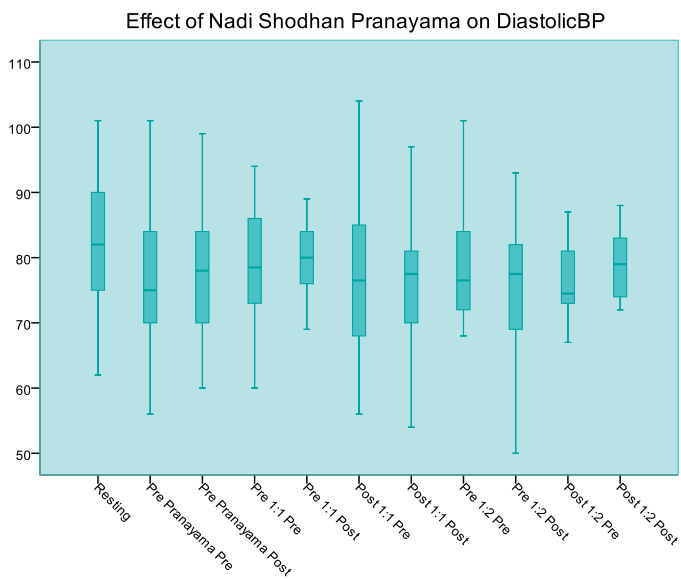
n=22	Mean	Std dev	F	Significance	25 percentile	50 percentile	75 percentile
Pulse-rate							
Pre-pranayama pre	73.05	9.94	0.370	0.830	64.75	72.00	77.00
Pre-pranayama post	76.23	11.20	(immediate effect of practice)		68.00	72.50	80.50
Pre 1:1 pre	80.82	11.99			74.25	79.50	92.00
Pre 1:1 post	81.00	10.93	5.246	0.001	74.25	78.00	89.75
Post 1:1 pre	80.64	12.53	(effect on 'pre' levels over		71.75	78.50	88.50
Post 1:1 post	81.82	11.88	diff. stages of practice)		72.00	78.50	91.25
Pre 1:2 pre	77.73	9.50			71.75	77.00	83.00
Pre 1:2 post	77.59	7.93	4.682	0.002	72.00	77.00	83.00
Post 1:2 pre	73.50	11.75	(effect on 'post' levels over		62.75	73.50	82.25
Post 1:2 post	73.50	10.32	diff. stages of practice)		64.00	71.50	84.00

Effect of Nadi Shodhan Pranayama on Systolic BP

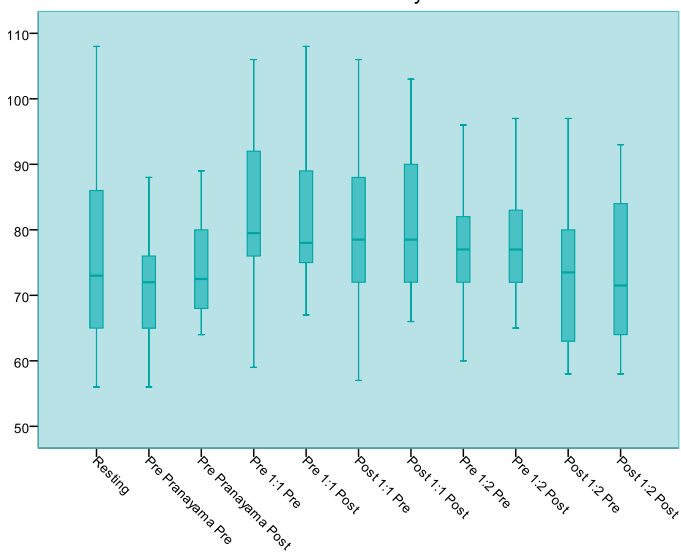


Immediate effect of Nadishodhan Pranayama - SBP

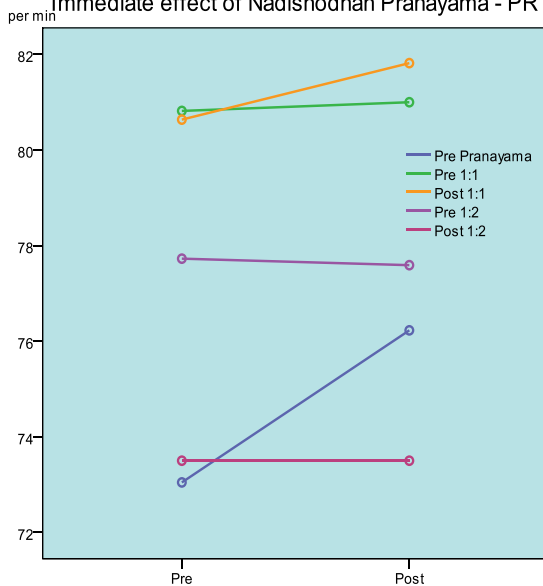




Effect of Nadi Shodhan Pranayama on Pulse-rate



Immediate effect of Nadishodhan Pranayama - PR

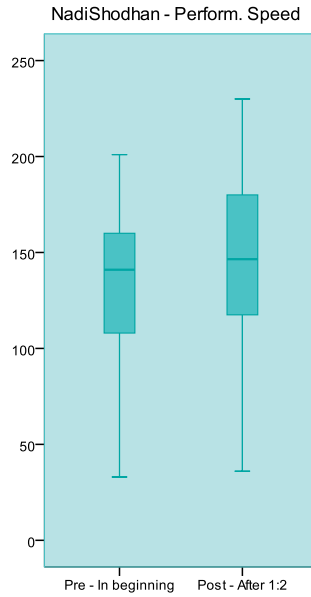
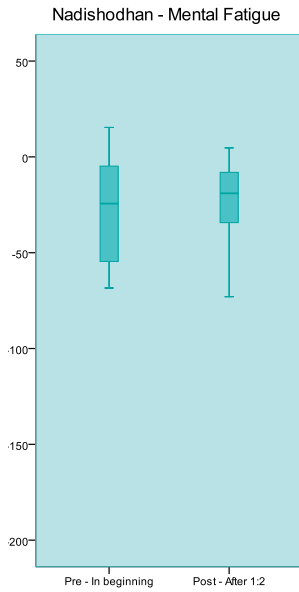
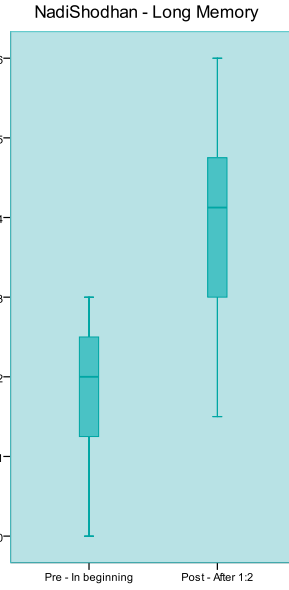
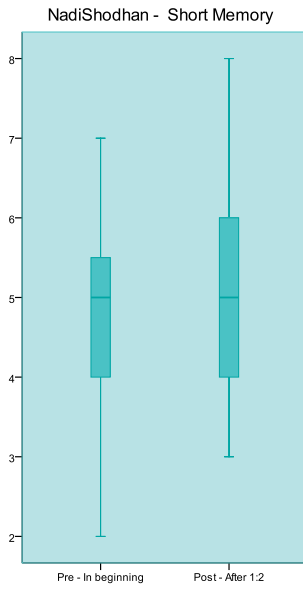


The short and the long-term memory tests were self-designed. The maximum possible score for short-term memory test was 9 and for the long-term memory test it was 6. In both tests the higher the score the better the memory. The short-term numerical memory increased marginally while the long-term memory increased significantly. See Table 4 and the accompanying graphs.

In the Mental Fatigue test only 2 persons showed mental fatigue in the pre-test and one in the post-test. The majority of subjects showed ‘practice’ effect i.e. as the time passed, instead of the mind becoming fatigued and the speed of multiplication being reduced and/or more errors made, their speed increased and/or less errors were made. This is evident by the negative values obtained for the coefficient of mental fatigue. Therefore, an attempt was made to see if their speed for mathematical calculations increased and/or if less errors were made. The performance speed increased but insignificantly. See Table 4 and the accompanying graphs.

Table 4: Psychological effects of nadi shodhana pranayama

n=22	Pre		Post		T test	Significance
	Mean	Std dev	Mean	Std dev		
<i>Short memory</i>	4.89	1.41	5.11	1.60	0.639	0.531
<i>Long memory</i>	1.93	1.04	3.84	1.26	6.679	0.000
<i>Mental fatigue</i>	-33.52%	42.52%	-25.58%	27.31%	1.593	0.128
<i>Perform speed</i>	139.48	52.21	147.80	58.50	1.043	0.310



We intended to study the effect of the pranayama on swara, pranic experience at ajna and mooladhara chakras, mood, physical energy level, alertness and calmness of mind by a self-designed questionnaire. Out of 22 subjects 11 answered the questionnaire designed to study practice experiences on a regular basis.

The subjects checked their swara before and after the practice. Nadi shodhana pranayama is expected to balance the swara and open sushumna as both the nostrils flow equally. Table 5 shows the effect of the practice on swara during the two one-month periods of constant count practice. The last column shows the number of occurrences of balanced swara out of 60 instances. Amongst 11 subjects the total occurrence of sushumna flow was 124 times out of 649 instances i.e. 19.11%.

The subjects noted their pranic experiences at ajna chakra and mooladhara chakra during and after the practice. Pranic experience at ajna chakra was found to occur very commonly and at mooladhara chakra comparatively less commonly. Table 6 shows the ability of the practice to generate pranic experiences at these two points during the two one-month periods of constant count practice. The last column shows the number of pranic experiences out of 120 instances (60 days means 60 instances **during** and 60 **after** the practice). Amongst 11 subjects the total number of pranic experiences at ajna were 935 or 70.83% and at mooladhara were 334 or 25.3%.

Table 5: Occurrence of sushumna

SNo	1:1		1:2		Total
	<i>Pre</i>	<i>Post</i>	<i>Pre</i>	<i>Post</i>	
1	1	13	0	15	28
2	0	0	0	0	0
3	3	3	4	4	7
4	0	0	0	0	0
5	4	9	0	13	22
6	0	0	0	0	0
7	4	4	10	10	14
8	3	2	5	5	7
9	9	8	11	10	18
10	0	2	1	9	11
11	10	12	5	5	17

Total: 124

Table 6: Pranic experience at ajna & mooladhara chakras

S No	1:1				1:2				Total	
	During		After		During		After			
	Ajn	Mool	Ajn	Mool	Ajn	Mool	Ajn	Mool	Ajn	Mool
1	28	21	28	24	29	20	30	25	115	90
2	29	10	29	5	30	8	28	7	116	30
3	6	0	5	0	7	0	7	0	25	0
4	7	1	11	1	12	7	17	9	47	18
5	30	0	30	0	27	0	24	0	111	0
6	29	0	30	0	29	11	30	14	118	25
7	29	14	28	17	23	14	23	14	103	59
8	25	1	27	3	25	5	27	5	104	14
9	25	0	25	0	13	0	30	12	93	12
10	27	21	29	27	20	15	27	23	103	86
11	0	0	0	0	0	0	0	0	0	0

Total: 935 334

Conclusion

This study was intended for 55 subjects but could only be effectively conducted on 22 subjects. The parameters of swara and pranic experience could be studied on 11 subjects. Hence a larger study is required in future to confirm the findings of the present study.

To summarize the results, the sub-hypotheses that regular practice of nadi shodhana pranayama with the ratio 10:10 for 10 rounds and 10:20 for 10 rounds will:

1. Increase BHT and PEFr was proved;
2. Increase short-term numerical and long-term memory was proved;
3. Increase speed and proficiency in repetitive mathematical tasks was proved;
4. Bring balance in swara was proved;
5. Generate pranic experience at ajna and mooladhara chakras was proved.

However, the sub-hypothesis that regular practice of nadi shodhana pranayama with the ratio 10:10 for 10 rounds and 10:20 for 10 rounds will:

6. Normalize and decrease pulse-rate, SBP and DBP could not be proved.

Physiological Effects of Ujjayi Pranayama, 2006–2007

Summary

YRF, in collaboration with BHEL (Bharat Heavy Electrical Limited), Bhopal, studied the effects of ujjayi pranayama on 41 subjects: 23 asthmatics, 11 hypertensives and 7 healthy adults. The pulse-rate was found to increase significantly (0.004) during the practice, more so in subjects who showed a higher pulse-rate and blood pressure (BP) at the outset. The oxygen saturation in capillary blood (SaO₂), contrary to expectations, improved only marginally and reverted back to pre level just after the practice. The BP was studied only in 11 hypertensives. It showed highly significant (0.000) reduction in systolic blood pressure (SBP) and clinically substantial reduction in diastolic blood pressure (DBP).

Introduction

Ujjayi pranayama brings about introversion and at the same time it stimulates focused awareness, an ideal mental state for the practice of *dharana*, concentration. At the physiological level ujjayi pranayama causes additional negative pressure during inhalation and additional positive airway pressure during exhalation in the chest cavity because one is breathing in and out through a partially contracted throat, pharynx. This encourages better gas exchange between lung tissue and blood. It slows down the flow of venous blood returning to the heart thus lowering the cardiac output and hence the BP. The lower cardiac output may increase the heart rate by local nervous reflex. The state of introversion activates the parasympathetic nerves and leads to vasodilatation, slowing of heart rate and decrease in systolic and diastolic BP. Ujjayi pranayama works in the area of anahata and vishuddhi chakras which govern the region of the heart, lungs and thyroid.

Aim

To observe the physiological effects of ujjayi pranayama.

Subjects

Participants of therapy courses of the Yoga Research Centre at BHEL, Bhopal, in the age group 35 to 65 years and both genders.

Parameters

Systolic BP	Digital BP instrument
Diastolic BP	Digital BP instrument
Pulse-rate	Pulse-oxymeter
Capillary oxygen saturation	Pulse-oxymeter

Method

Twenty-four participants from an asthma course, 11 from a hypertension course and 7 healthy participants of a general yoga course run by the Yoga Research Centre, BHEL, Bhopal, were taught ujjayi pranayama with khechari mudra. On the day of data collection, each participant was guided individually first to relax and then start the ujjayi pranayama. He/she was continuously guided during the practice for the next 5 minutes and then guided to the end the practice. The participant sat quietly without externalizing for the next 2 minutes until the data collection was complete. The above-mentioned 4 parameters were measured. The following readings were noted using pulse-oxymeter – baseline, at the beginning, every minute for 5 minutes of practice, at the end and post 1 and 2 minutes (total 10 readings). Also, BP was measured 4 times – pre, at end of 2 and 5 minutes during the practice, and 2 minutes post. The data was processed using SPSS 17 software to calculate F statistics and the significance of change due to the practice of ujjayi pranayama.

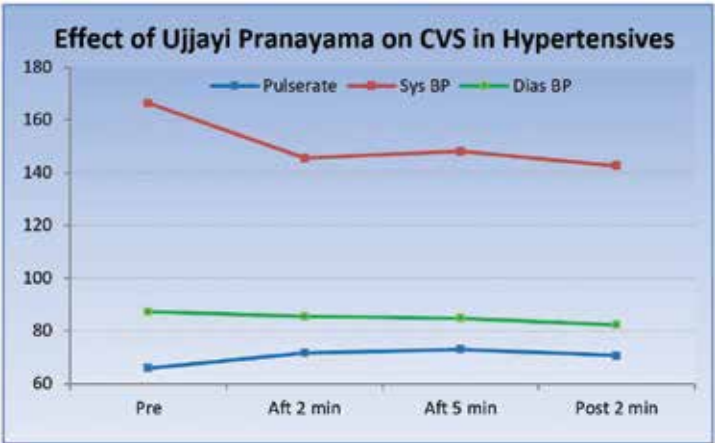
Result

Blood pressure was monitored only in the subgroup of 11 hypertensive subjects. The **systolic BP showed highly**

significant (0.000) and clinically substantial reduction which further continued after ending the practice. **The maximum fall in the systolic BP was in the first 2 minutes.** The **diastolic BP showed steady and clinically useful reduction** which continued after completing the practice. The reduction was not statistically significant (0.179) due to the small number of subjects. This subgroup, as compared to other subgroups, showed a greater and **highly significant (0.000) increase in pulse-rate.** See Table 1 and the accompanying graph.

Table 1: Effect of ujjayi pranayama on CVS in hypertensive subjects (mean values)

n=11	Systolic BP		Diastolic BP		Pulse-rate	
	Mean	Std dev	Mean	Std dev	Mean	Std dev
Pre	166.27	20.60	87.27	12.73	65.82	9.92
2 min	145.55	19.35	85.36	10.86	71.64	11.48
5 min	148.09	19.65	84.82	11.19	73.00	12.71
Post 2 min	142.64	19.23	82.27	9.75	70.55	9.85
F value	21.421		2.095		8.348	
Significance	0.000		0.179		0.000	



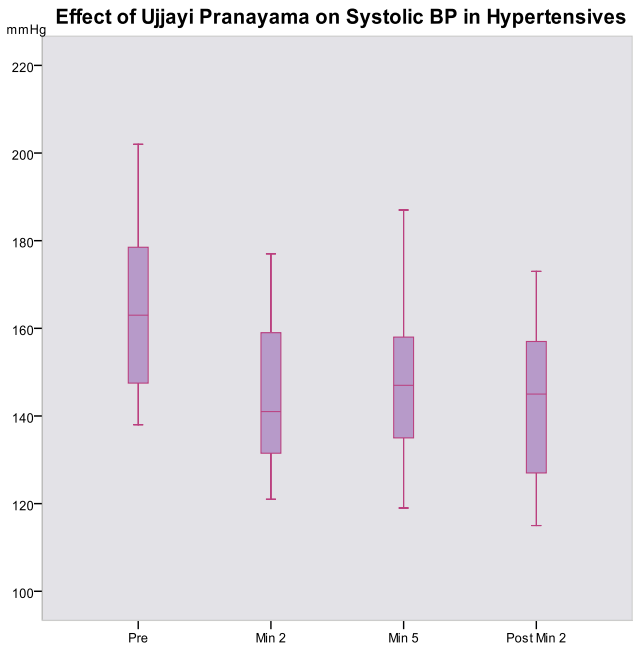
The effect of ujjayi pranayama on CVS can be more clearly understood when the data is presented in percentile format. It shows the pattern of response amongst the lower range (25 percentile), the middle range (50 percentile) and the higher range (75 percentile) of HBP. After the initial great fall in SBP in all the three range groups, the high range group showed a small but steady fall in SBP throughout the practice and after. The post-practice fall in SBP was most marked in the lower range group. The decrease in diastolic BP was highest in the high range group and lowest in the low range group. Ujjayi pranayama caused the pulse-rate to increase. The low range subjects were affected the least and the high range subjects the most. **The higher range of HBP subjects benefited the most due to ujjayi pranayama.** See Table 1a and the accompanying graphs.

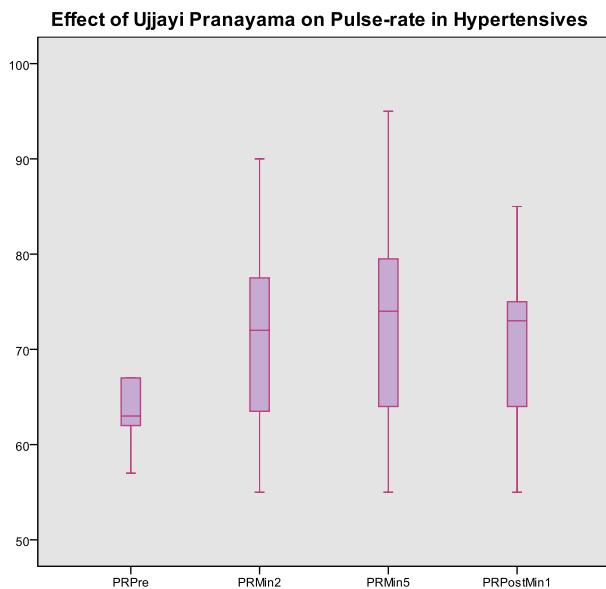
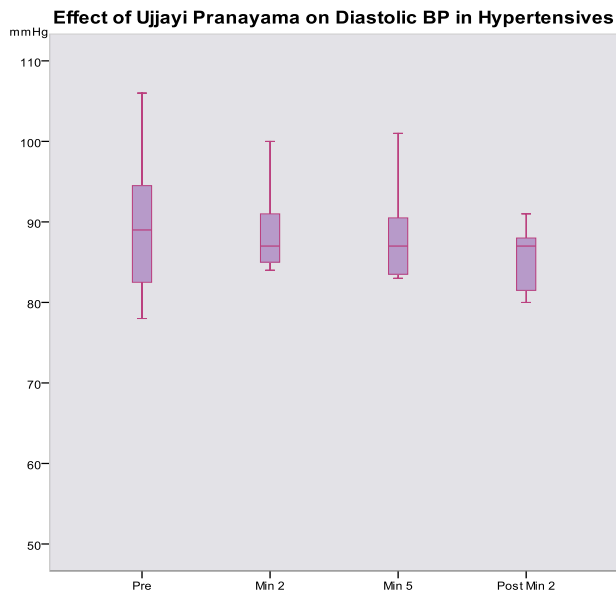
Table 1a: Effect of ujjayi pranayama on CVS in hypertensive subjects (percentile values)

n=11	Systolic BP		
	25 percentile	50 percentile	75 percentile
<i>Pre</i>	147.50	163.00	178.50
<i>2 min</i>	131.50	141.00	159.00
<i>5 min</i>	135.00	147.00	158.00
<i>Post 2 min</i>	127.00	145.00	157.00

n=11	Diastolic BP		
	25 percentile	50 percentile	75 percentile
<i>Pre</i>	82.50	89.00	94.50
<i>2 min</i>	85.00	87.00	91.00
<i>5 min</i>	83.50	87.00	90.50
<i>Post 2 min</i>	81.50	87.00	88.00

n=11	Pulse-rate		
	25 percentile	50 percentile	75 percentile
Pre	62.00	63.00	67.00
2 min	63.50	72.00	77.50
5 min	64.00	74.00	79.50
Post 2 min	64.00	73.00	75.00





The pulse-rate and oxygen saturation in capillary blood, SaO₂, were observed in all the three subgroups. **The pulse-rate showed significant (0.004) and uniform increase in all subgroups** which approached the initial values immediately after ending the practice. The increase was highest in the 75 percentile group, that is in subjects with high ‘pre’ pulse-rate, moderate in the middle group and it actually decreased in the 25 percentile group, in subjects with slower pulse-rate at the outset. The increase was more in the hypertensive subgroup. The rise in pulse-rate could be a compensatory effect to the decrease in BP.

The **SaO₂ showed insignificant (0.336) improvement** during the practice which reverted back to initial values immediately on ending the practice. The improvement did not touch 100% value at any time. See Tables 2, 2a and 3 and the accompanying graphs.

Table 2: Effect of ujjayi pranayama on pulse-rate (mean)

n=41	Mean		
	<i>Asthma (n=23)</i>	<i>Healthy (n=7)</i>	<i>High BP (n=11)</i>
<i>Pre</i>	81.05	81.29	65.82
<i>Start</i>	77.82	77.57	67.45
<i>1 min (khechari)</i>	78.50	76.71	70.18
<i>2 min</i>	80.14	78.00	71.64
<i>3 min</i>	79.64	78.86	72.55
<i>4 min</i>	81.59	79.57	74.27
<i>5 min</i>	81.82	80.14	73.00
<i>End</i>	79.32	78.71	71.64
<i>Postcardio1 min</i>	77.91	77.29	70.55

Effect of ujjayi pranayama on SaO2 (mean)

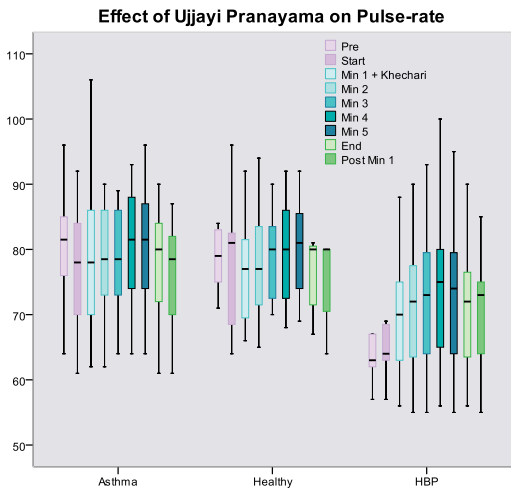
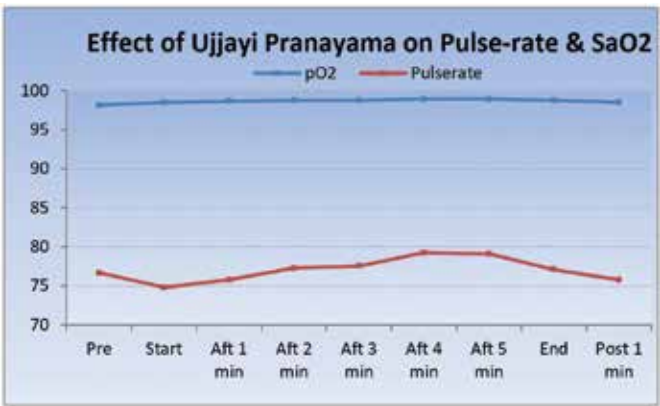
n=41	Mean		
	Asthma (n=23)	Healthy (n=7)	High BP (n=11)
Pre	97.55	99.29	98.73
Start	97.91	99.14	99.27
1 min (khechari)	98.00	99.29	99.45
2 min	98.23	99.14	99.45
3 min	98.32	99.14	99.45
4 min	98.36	99.29	99.73
5 min	98.50	99.29	99.55
End	98.27	99.14	99.45
Post 1 min	97.82	99.29	99.36

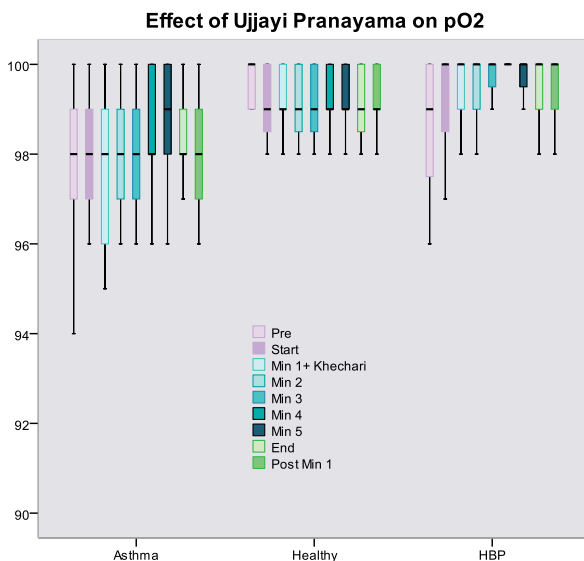
Table 2a: Effect of ujjayi pranayama on pulse-rate (percentile)

Subgroup	Period	25 percentile	50 percentile	75 percentile
Asthma	Pre	76.00	81.50	85.00
	2 min	73.00	78.50	86.00
	5 min	74.00	81.50	87.00
	Post 1 min	70.00	78.50	82.00
Healthy	Pre	75.00	79.00	83.00
	2 min	71.50	77.00	83.50
	5 min	74.00	81.00	85.50
	Post min 1	70.50	80.00	80.00
HBP	Pre	62.00	63.00	67.00
	2 min	63.50	72.00	77.50
	5 min	64.00	74.00	79.50
	Post 1 min	64.00	73.00	75.00

Table 3: Statistical significance of effects of ujjayi pranayama

n=41; *n=11	F	Significance	Partial eta squared	Observed power
Systolic BP*	21.421	0.000	0.889	1.000
Diastolic BP*	2.095	0.179	0.440	0.354
Pulse-rate	3.934	0.004	0.470	0.952
SaO2	1.192	0.336	0.212	0.425





Conclusion

The pulse-rate increased significantly during the practice but went back to the initial level once the practice was completed. The increase in pulse-rate was greater in the hypertensive subgroup and in subjects with higher initial pulse-rate.

Contrary to our expectations, the capillary oxygen saturation improved only to a small extent, not significantly.

In the hypertensive subgroup (n=11) systolic BP reduced significantly. The reduction in diastolic BP was insignificant but clinically useful. Both systolic and diastolic BP continued to reduce further even after cessation of the practice.

Effect of Pranayamas in Hypertensives, 2006–2007

Summary

Effects of various pranayamas on blood pressure (BP), pulse-rate and oxygen saturation in capillary blood in hypertensive subjects was studied. Thirty subjects were in the nadi shodhana pranayama (stage 2 with ratio 1:1) group, 11 in the ujjayi pranayama group and 10 in the bhramari pranayama group. The effects of 5 minutes of practice on the above parameters were studied pre, throughout the practice and up to 2 minutes post. Oxygen saturation (SaO₂) improved, systolic BP came down significantly (ujjayi being the most effective pranayama practice), diastolic BP decreased especially with nadi shodhana pranayama and the pulse-rate increased marginally in the beginning, probably as compensation to lowered BP but settled down to pre level later. All three pranayamas were found to be beneficial for people with high BP.

Introduction

Pranayamas are classified into three categories: stimulating or extroverting, like kapalbhati and bhastrika; calming or introverting, like bhramari and sheetali; and balancing, like nadi shodhana pranayama. The first category stimulates pingala nadi or the sympathetic nervous system, the second one stimulates ida nadi or the parasympathetic nervous system, and the last category balances ida-pingala and stimulates sushumna nadi. Ujjayi pranayama has a calming effect with alertness, while bhramari pranayama has a soothing calming effect.

Aim

To study the effects of different pranayamas on the capillary oxygen saturation (SaO₂) and cardiovascular system in hypertensive subjects.

Research design

Uncontrolled, Repeated measure design, F statistics (General linear model, Repeated measure) using SPSS 17 software to calculate the significance of the results obtained.

Subjects

Thirty participants of a therapy course for hypertension conducted by Yoga Research Centre at BHEL, Bhopal. There were 18 males and 12 females. Their age ranged from 39 to 75 years with an average 57.5 years.

Parameters

Capillary oxygen saturation SaO ₂	Pulse-oxymeter	(3 pranayamas)
Pulse-rate	Pulse-oxymeter	(2 pranayamas)
Systolic BP and diastolic BP	Digital BP instrument	(2 pranayamas)

Method

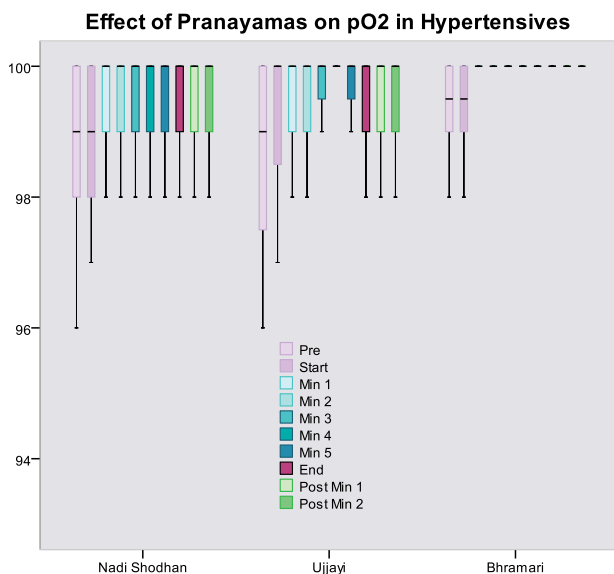
Thirty participants of a therapy course run by Yoga Research Centre of BHEL, Bhopal, were taught nadi shodhana pranayama stage 2 with ratio 1:1, bhramari pranayama and ujjayi pranayama with khechari mudra in due course. On the day of data collection each participant was guided individually first to relax and then start the pranayama concerned. He/she was continuously guided during the practice for the next 5 minutes and then guided to end the practice. The participant sat quietly without externalizing for the next 2 minutes until the data collection was complete. For each pranayama SaO₂ and pulse-rate were noted using pulse-oxymeter: baseline, at start, every minute for 5 minutes of practice, at the end and post 1 and 2 minutes (total 10 readings). The pulse-rate data for bhramari pranayama was not available. For nadi shodhana and ujjayi pranayamas BP was also measured 4 times – pre, after 2 and after 5 minutes of the practice and 2 minutes post.

Results

In all three pranayamas the capillary oxygen saturation showed steady improvement as the practice of pranayama progressed and remained steady at that level for 2 minutes post also. As the SaO₂ levels were very close to normal, 100%, at the outset, the scope for improvement and comparison within the three practices was very small and hence the data was not found to be significant (NS=F 1.205, significance 0.343; Uj=F 2.1, significance 0.196; Bh=F 1.177, significance 0.457). The improvement was better with ujjayi and bhramari pranayamas. See Table 1 and accompanying graph.

Table 1: Effect of pranayamas on SaO₂ in hypertensive subjects

NS=30, U=11, B=10	Nadi shodhana pranayama		Ujjayi pranayama		Bhramari pranayama	
	Mean	Std dev	Mean	Std dev	Mean	Std dev
Baseline	98.93	1.17	98.73	1.49	99.30	0.82
Start	99.13	0.90	99.27	1.10	99.00	1.56
1 min	99.33	0.96	99.45	0.82	99.80	0.42
2 min	99.20	1.30	99.45	0.93	99.80	0.42
3 min	99.27	1.26	99.45	1.04	99.70	0.68
4 min	99.30	1.26	99.73	0.65	99.80	0.42
5 min	99.23	1.68	99.55	0.82	99.80	0.42
End	99.50	1.17	99.45	0.82	99.90	0.32
Post 1 min	99.37	1.22	99.36	0.81	99.90	0.32
Post 2 min	99.27	1.34	99.45	0.82	99.80	0.42
F	1.205		2.100		1.177	
Significance	0.343		0.196		0.457	



The pulse-rate and BP were also monitored during the practices of all three pranayamas.

Nadi shodhana pranayama showed a small rise in pulse-rate as the practice proceeded. It started settling towards the end of the practice and settled to pre level by the end of 2 minutes post. The rise in pulse-rate was significant (F 1.205, significance 0.000). Nadi shodhana pranayama showed very significant reduction in systolic BP as the practice progressed. It continued to fall 2 minutes after the cessation of the practice (F 9.544, significance 0.000). Similarly diastolic BP also reduced very significantly during and continued to fall 2 minutes after the practice (F 5.848, significance 0.004).

Ujjayi pranayama also showed a small insignificant rise in pulse-rate with the progress of the practice (F 1.190, significance 0.537). It started settling towards the end of the practice and settled to almost the pre level by the end of 2 minutes post. It showed greater and significant reduction in systolic BP (F 21.421, significance 0.000) but the response

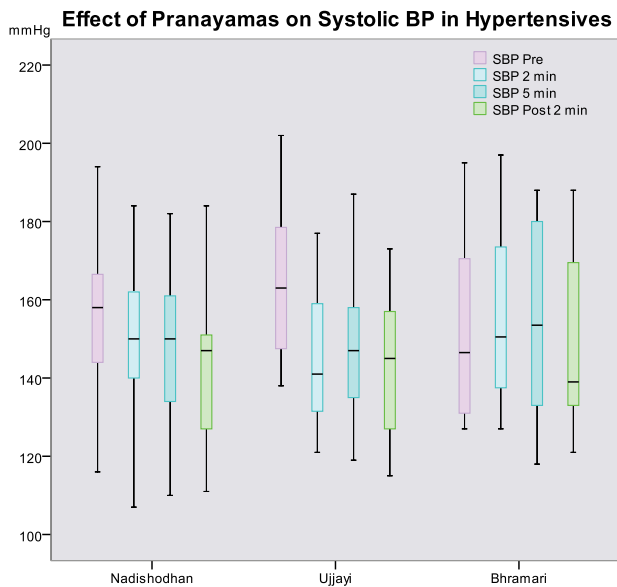
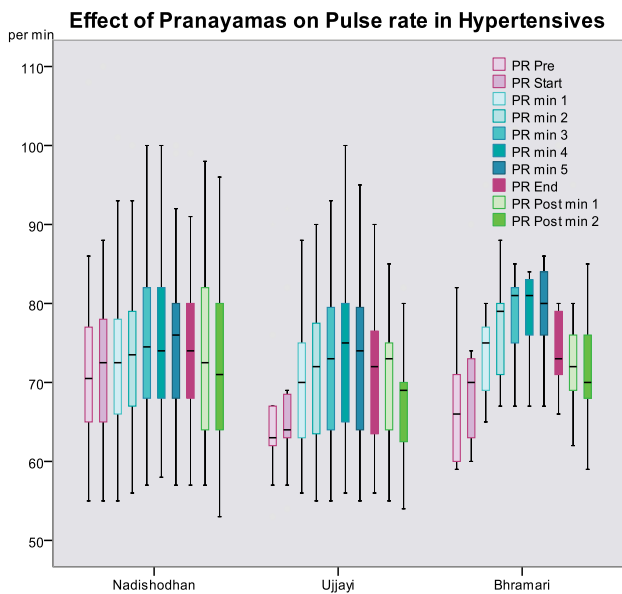
for diastolic BP was equivocal, initial rise and later reduction (F 2.095, significance 0.179). This could be due to the effort made by the participants while breathing in ujjayi.

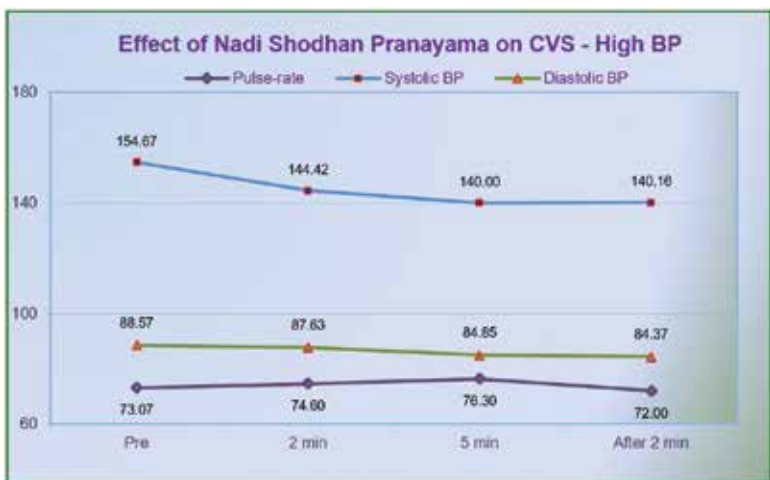
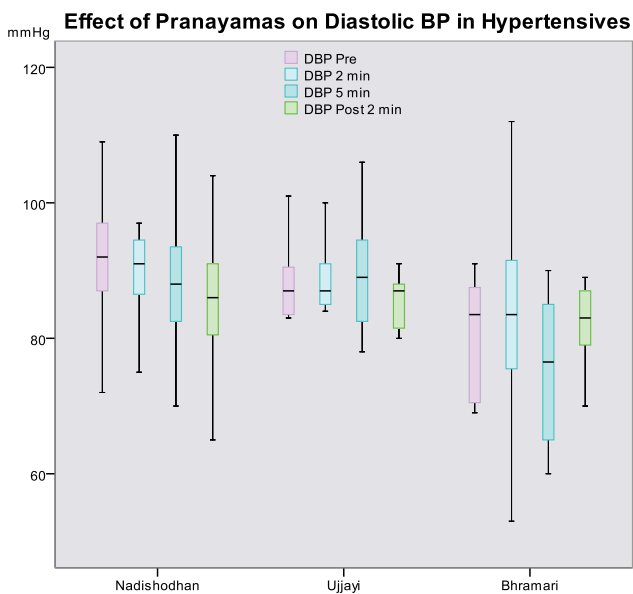
The results of bhramari pranayama were totally unexpected. It showed a rise in pulse-rate throughout the practice with a tendency to come to pre level by the end of 2 minutes post but did not reach pre level. The BP response was equivocal; the systolic BP increased with practice and dropped later while the diastolic BP decreased towards the end of the practice but bounced back in the post 2 minutes period. The F value and significance were not calculated. See Table 2 and accompanying graphs.

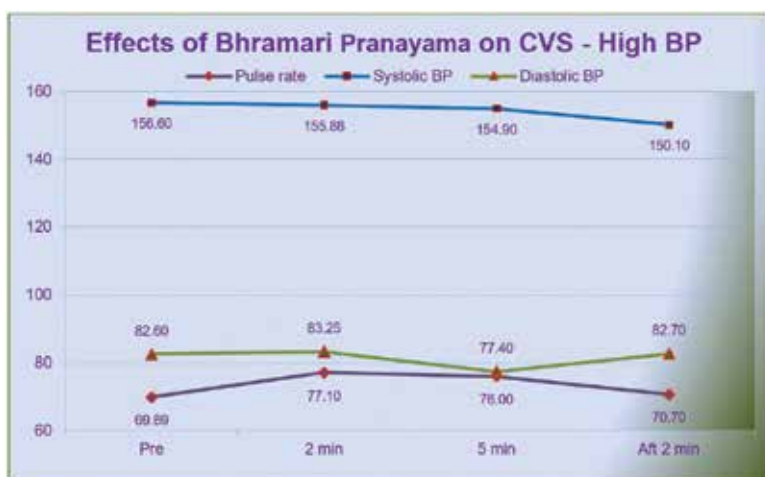
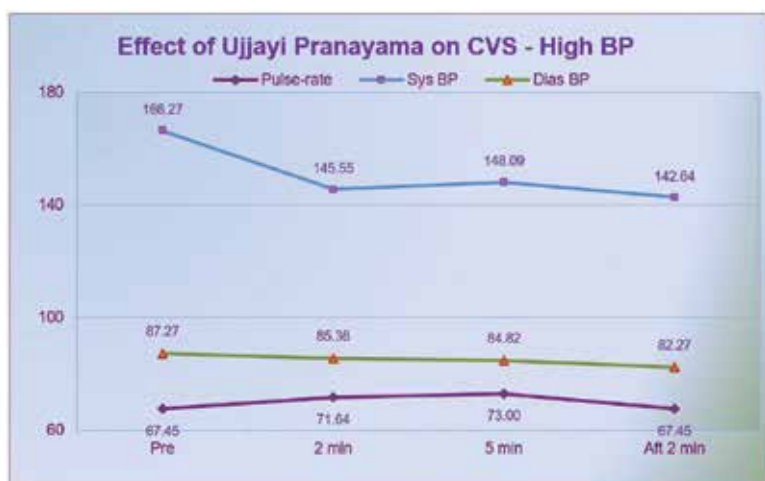
Table 2: Effect of pranayamas on cardiovascular system in hypertensive subjects

	Pulse-rate		Systolic BP		Diastolic BP	
	Mean	Std dev	Mean	Std dev	Mean	Std dev
Nadi shodhana pranayama (n=30)						
<i>Baseline</i>	71.93	10.63				
<i>Start</i>	73.07	10.99				
<i>1 min</i>	73.50	10.13				
<i>2 min</i>	74.60	9.93				
<i>3 min</i>	75.33	9.99				
<i>4 min</i>	76.37	10.70	150.33 17.89		89.78 9.27	
<i>5 min</i>	76.30	10.62				
<i>End</i>	75.10	10.77				
<i>Post 1 min</i>	73.63	10.35				
<i>Post 2 min</i>	72.00	9.84	142.93	18.82	85.48	8.89
<i>F</i>	5.888		9.544		5.848	
<i>Significance</i>	0.000		0.000		0.004	

Ujjayi pranayama (n=11)						
Baseline	65.82	9.92				
Start	67.45	10.86	166.27	20.60	84.82	11.19
1 minute	70.18	10.46				
2 minute	71.64	11.48	145.55	19.35	85.36	10.86
3 minute	72.55	12.76				
4 minute	74.27	13.87				
5 minute	73.00	12.71	148.09	19.65	87.27	12.73
End	71.64	11.18				
Post 1 min	70.55	9.85				
Post 2 min	67.45	8.76	142.64	19.23	82.27	9.75
F	1.190		21.421		2.095	
Significance	0.537		0.000		0.179	
Bhramari pranayama (n=10)						
Baseline	67.22	7.429				
Start	69.89	8.992	152.25	24.737	80.38	9.007
1 minute	75.22	9.121				
2 minute	78.67	10.416	155.88	23.811	83.25	17.219
3 minute	79.78	10.281				
4 minute	81.11	11.805				
5 minute	81.11	12.015	154.88	26.904	75.38	11.376
End	76.00	10.100				
Post 1 min	74.11	9.400				
Post 2 min	71.89	8.388	149.00	24.750	82.13	6.266
F	---		---		---	
Significance	---		---		---	







Conclusion

In hypertensive subjects nadi shodhana, ujjayi and bhramari pranayamas improve oxygenation of blood and the first two pranayamas are also effective in normalizing elevated BP and pulse-rate.

Physiological Effects of Pranayamas, 1998–2001

Summary

The basic cardiovascular system (CVS) effects, systolic and diastolic BP and pulse-rate, of three pranayamas, nadi shodhana stage 2 with the ratio 1:1, bhramari and ujjayi, were studied in 60 subjects, of which 50 had high BP and 10 had normal BP. Nadi shodhana (NS) pranayama significantly reduced both systolic and diastolic BP (SBP and DBP) with compensatory rise in pulse-rate (PR). Ujjayi (Uj) pranayama showed significant reduction in SBP, less than significant reduction in DBP and significant elevation in PR. Bhramari (Bh) pranayama showed reduction in SBP and PR and stable DBP. These effects were more pronounced in the hypertensive group than in the normotensive group.

Introduction

The introverting or ida stimulating pranayamas like bhramari and ujjayi as well as the balancing pranayama, nadi shodhana, try to nullify the normal overtone of pingala nadi or the sympathetic nervous system. They allow the potential effects of ida nadi or the parasympathetic nervous system to become manifest. In normal day-to-day interactions in the external world, the sympathetic stimulation is inevitable and also necessary. However, a constant overactive pingala over long periods of time ultimately results in a permanent change in blood vessels leading to high BP. The practice of these three pranayamas undoes this negative side effect of our present-day competitive lifestyle and resettles the CVS physiological parameters within their normal range. In the current experiment Yoga Research Foundation (YRF) tried to study the effects of certain pranayamas on these simple but very important parameters.

Aim

To observe the physiological effects of different pranayamas on the cardiovascular system.

Research method

Uncontrolled, pre-post design. t test statistics used to calculate the significance of the results obtained.

Parameters

Systolic BP	Digital BP instrument	Pre & post
Diastolic BP	Digital BP instrument	Pre & post
Pulse-rate	Digital BP instrument	Pre & post

Method

Sixty participants of various 17-day health management courses conducted by Bihar School of Yoga, Munger, from 1998 to 2001, were observed for the cardiovascular effects of three different pranayamas. The subjects were randomly assigned to one of the three pranayamas. Fifty participants had come to these courses for high BP or had associated hypertension along with some other health issues. The remaining 10 participants had normal BP. Pre data was collected for the above three parameters. They were then subjected to any of the three pranayamas at random. Nadi shodhana pranayama was practised to the ratio 1:1 for 10 rounds. Bhramari pranayama was practised for 11 rounds and ujjayi pranayama was practised for 3 minutes. At the end post data was collected.

Result

Pranayamas are found to have a profound effect on BP. Bhramari pranayama had too small a number of subjects and therefore its results only indicate a possibility. Ujjayi pranayama data is just sufficient to indicate a direction.

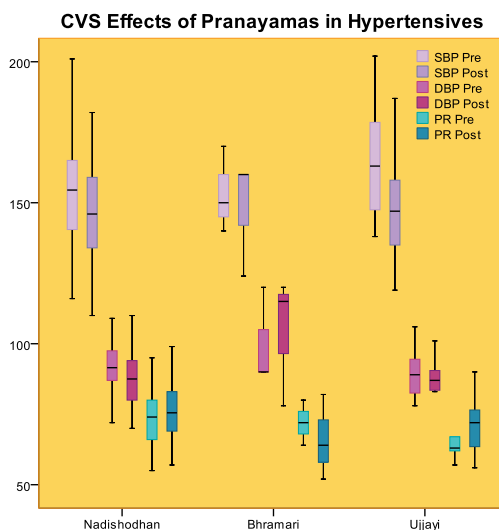
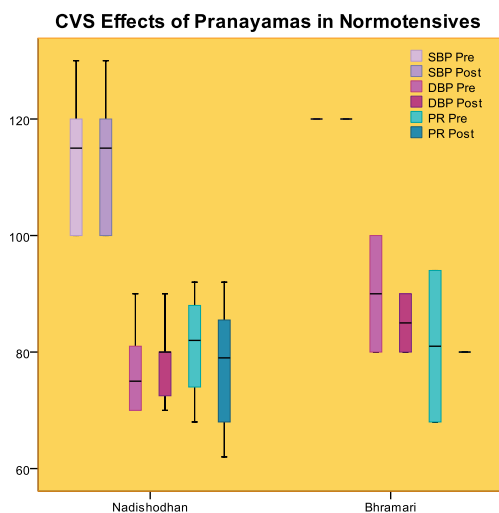
The effects of each pranayama on hypertensive and normotensive subjects were analyzed separately.

In the hypertensive subgroup nadi shodhana pranayama (NS) showed a highly significant reduction in systolic and diastolic BP and a significant rise in pulse-rate. The ujjayi group, though small, showed a significant reduction in systolic BP and a small insignificant fall (larger group would have shown a significant fall) in diastolic BP. This was accompanied by a significant rise in pulse-rate, probably to compensate the fall in BP. The bhramari group was too small to indicate anything but it seemed to reduce systolic BP and the pulse-rate and elevate diastolic BP. See Table 1 and the accompanying graphs.

In the group with normal BP, ujjayi pranayama was not studied and bhramari had an insufficient number of subjects to conclude anything. Nadi shodhana had a small number of subjects but it was sufficient to indicate a direction. It showed no or minimal changes in systolic as well as diastolic BP and a small reduction in pulse-rate. See Table 1 and the accompanying graphs.

Table 1: CVS effects of individual pranayamas in hypertensive and normotensive groups

High BP subgroup (n=50)											
	Systolic BP				Diastolic BP				Pulse-rate		
	Pre	Post	T test	Signifi	Pre	Post	T test	Signifi	Pre	Post	T test
NS (n=36)	154.42	145.83	4.638	0.000	92.03	87.67	3.655	0.001	73.92	76.39	2.642
Bh (n=3)	153.33	148.00	0.396	0.731	100.00	104.33	0.334	0.770	72.00	66.00	1.441
Uj (n=11)	166.27	148.09	6.169	0.000	87.27	84.82	0.977	0.352	65.82	71.64	3.107
Normal BP subgroup (n=10)											
	Systolic BP				Diastolic BP				Pulse-rate		
	Pre	Post	T test	Signifi	Pre	Post	T test	Signifi	Pre	Post	T test
NS (n=8)	112.50	112.50	0.000	1.000	76.50	78.13	0.540	0.606	81.00	77.38	1.311
Bh (n=2)	120.00	120.00	0.000	1.000	90.00	85.00	1.000	0.500	81.00	80.00	0.077
Uj (n=0)	na	na	na	na	na	na	na	na	na	na	na



Conclusion

Both nadi shodhana pranayama and ujjayi pranayama are very effective in reducing systolic and diastolic blood pressure. Their effect on pulse-rate is generally compensatory.

Yoga Nidra

Introduction

Yoga nidra performs two beneficial functions: firstly it removes fatigue and invigorates the body, and secondly it removes tension and restores the elasticity of the mind. The dross of day-to-day life is deposited in the subconscious mind and in due course it exerts a deleterious influence on one's mental makeup. Just as a house must be swept daily to keep it clean, similarly to have a normal personality, the *samskaras*, the mental dirt that accumulates daily in the subconscious, must be removed. Yoga nidra performs this essential service for us, removing our mental abnormalities and clearing the way to spiritual progress.

Most diseases and errors in behaviour which one attributes to present circumstances have an intimate connection with one's past and one's early childhood. This means that diseases pertaining to the body and the problems pertaining to the mind and one's difficulty in adjusting to circumstances and the environment, are not necessarily due to the present circumstances. They may be deeply rooted in some of the impressions or experiences of one's childhood. Therefore, it is necessary for everyone to follow the whole series of their experiences right from childhood. However, these impressions and experiences are so strongly embedded in the subconscious that unless total relaxation of the mind takes place they do not really come up. One can never see them, feel them or know

them. It is only when complete relaxation has taken place, when the mind, the senses and the present experiences are withdrawn that the subconscious mind emerges and comes up to the surface level.

During yoga nidra, the subconscious mind is brought to the surface and one is able to perceive a series of experiences, of karma or impressions, which have been buried in your subconscious mind for years, from one's childhood up to this day. In yoga nidra, the emphasis is on relaxation together with unified or total awareness.

Those who want to influence themselves and impress their personality through yoga nidra must make some kind of a resolve, an auto-suggestion, at the beginning of the practice. The individual consciousness becomes so sensitive and receptive during the practice of yoga nidra that if one tries to influence oneself one can. This indicates the importance of the deeper layers of the consciousness. There are much deeper, higher and more potential states of individual awareness than we are aware of at this moment. Every state of consciousness has its own limitations of experience. The particular state of consciousness in which we exist now is more limited than the subconscious state which we usually experience in yoga nidra. In this psychic sleep there is a greater possibility to induce a new system of thinking, a new process of adjustment and also an absolutely new process of tranquillity.

I call yoga nidra 'taming the wild monkey'. It is a technique of taming this wild monkey, the human mind. This anarchical mind, this disorderly, broken and schizophrenic mind can be brought into a beautiful pattern if yoga nidra is practised correctly.

—*Swami Satyananda Saraswati*

Yoga nidra has been practised throughout history. Napoleon practised yoga nidra sitting on his horse before he entered the battlefield. Mahatma Gandhi used it every time he needed to work through the night. Even a former Colombian president used the short yoga nidra technique. Puzzled by his level of energy, when his subordinates asked him the secret to his energy levels, the president's reply was crystal clear. He said, "Whenever I tire, I practise yoga nidra."

—*Swami Niranjanananda Saraswati*

* For further information on yoga nidra and full transcripts of the practice, refer to the book *Yoga Nidra* by Swami Satyananda Saraswati (Yoga Publications Trust, Munger, Bihar, India).

Physical Manifestations of Relaxing Effects of Yoga Nidra, 1989–1990

Summary

The practice of yoga nidra is an efficient tool to lower the systolic and the diastolic blood pressure (SBP and DBP) and pulse-rate. The reduction in each parameter is highly significant and clinically substantial, which reflects on the ability of yoga nidra to relax the person deeply and totally.

Introduction

The pratyahara practice of yoga nidra is an invaluable gift from Swami Satyananda Saraswati to humanity. It is unparalleled in its ability to bring about relaxation at all levels: physical, psychological, emotional and psychic. It has been one of the most popular yoga practices amongst researchers. Innumerable aspects of this practice have been researched over the past decades. Yoga Research Foundation presents here a simple and basic study on this unanimously popular practice.

Aim

To observe the physical manifestations of relaxing effects of yoga nidra.

Method

Twenty participants of a health management course conducted by the Bihar School of Yoga, Munger, Bihar, were observed for the cardiovascular manifestations of the relaxing effect of yoga nidra. Each subject had one or more health problems, such as high BP, ischemic heart disease, diabetes, spondylitis, joint pain, backache and asthma. They were informed about the study and the practice of yoga nidra. Informed consent was obtained from each person. Their systolic and diastolic BP and pulse-rate were measured

and recorded using a digital BP machine. The participants were then given a full practice of yoga nidra and again all the three parameters were measured. One participant disqualified from the study as he was very restless and left the classroom halfway through the practice.

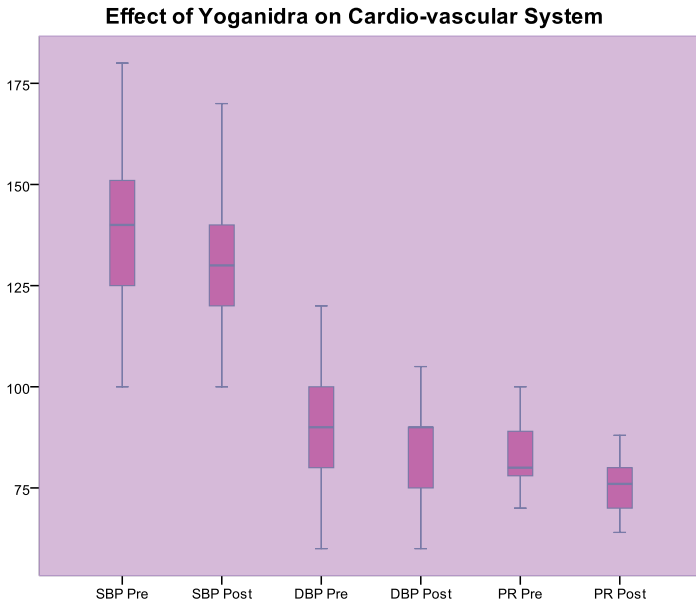
Results

The majority of subjects, 75%, had high BP or diabetes.

Table 1: Cardiovascular effects of yoga nidra

n=19		Mean	Std dev	t test	Significance
SBP	Pre	138.21	20.61	4.286	0.000
	Post	128.95	18.50		
DBP	Pre	89.37	15.80	3.525	0.002
	Post	82.32	11.89		
Pulse-rate	Pre	83.37	10.37	3.566	0.002
	Post	75.47	8.11		

n=19		25 percentile	50 percentile	75 percentile
SBP	Pre	120.00	140.00	152.00
	Post	120.00	130.00	140.00
DBP	Pre	80.00	90.00	100.00
	Post	70.00	90.00	90.00
Pulse-rate	Pre	76.00	80.00	90.00
	Post	68.00	76.00	80.00



Conclusion

Yoga nidra can lead to highly significant reduction in systolic as well as diastolic blood pressure and pulse-rate. The practice can be of great use in the management of high blood pressure, ischemic heart disease and diabetes. It is very useful in the management of stress and its side effects.

Yoga Nidra and Creativity

What is creativity?

The word ‘creativity’ is used often, however, it is limited to express an ability to create a beautiful and artistic object or the ability to imagine vividly. No scientist, philosopher or expert has been able to define creativity accurately. As a result there are many definitions of creativity. Simply speaking, creativity is a skill to see a common or difficult situation from an uncommon perspective or to imagine something extraordinary and ensure it comes to fruition. The end product of creativity is to bring forth something original and useful.

Creativity – nature or nurture?

We are all creative by nature. We experience creative thinking in our lives in the form of sudden insights or extraordinary leaps of understanding. It usually happens after a long period of hard work when we let go of our efforts and when we least expect it. In other words, when we do our part to the best of our abilities and then either consciously allow the higher energy to do its share or give up our efforts accepting the situation, then suddenly, after a lapse of time a creative idea dawns from somewhere within us.

We lose much of our creativity during school years through neglect and cultural conditioning. Young children are constantly told what to do and what not to do; what is right and what is wrong. Many times adults are so involved in their own lives that they have no time to share the child’s experiences and excitements. The child is overburdened with the load of formal education. Some of the urban children miss out on being in a natural environment. Such adult behaviour at home and at school suppresses or kills spontaneity and originality in the child’s personality. However, we still retain the potential to reactivate our creative ability.

Thinking pattern in creative people

There are two ways in which our mind tends to think. In ordinary or linear thinking we seek a single correct answer by using a one-pointed, concentrated mind. We tend to think only in one direction by ruling out other common possibilities. It is conscious thinking, executed by exercising one's will. It mainly uses the left brain. In most of our day-to-day dealings and problem solving we use this mode of thinking. Yogic practices of pranayama, pratyahara and dharana enhance this human ability by calming the mind and preparing it to apply itself to any given task with full awareness.

In contrast, in lateral thinking we try to collect as many possibilities including absurd ones. It is subconscious or unconscious thinking. There is no effort on the part of an individual. It is supported by a relaxed state of mind. It uses the whole brain. One needs to get in tune with one's inner self. The state of mind in which the brain activity shows alpha waves is more conducive to creative or lateral thinking e.g. just before falling asleep or an introverted state of mind. Yogic practices of relaxation such as yoga nidra, internalizing and mind-quietening practices such as mantra japa, chidakasha dharana and bhakti yoga enhance the ability to think in a lateral mode by training an individual to relax at will, quieten the mind and establish a connection with one's inner core.

Creative thinking involves conscious, focused, alert thinking which is followed by trance-like unfocused thinking. The later state can be induced by relaxation in order to recall specific memories or visualize something vividly. In this state, memories, situations and impressions are being sorted out mentally. Children and some adults can often adopt this state and become oblivious to everything around them. 'Going inside' is one of the main foundational skills for creativity. We are able to switch from one level of consciousness to the other quite rapidly. Even during a conversation we may go into a brief period of inner reflection or memory

recollection. All the practices of pratyahara, dharana and dhyana enhance this ability to dive inside.

Personality type of creative people

Physical stress and emotional disturbance take away one's ability to think with one-pointed concentration as well as to dive within. One can effectively manage the physical and mental stress with asana and pranayama practices. *Yamas*, the practices of social code of conduct, improve one's dealings with other people thus reducing the chances of emotional disturbances. *Niyamas*, the practices of self-discipline, help one to find and maintain balance in situations evoking emotional disturbance. The concept of balance or moderation through a yogic lifestyle also keeps these stresses to minimum.

People with an adjusting nature and an attitude of looking at the brighter side of a situation have more creative ability. They tend to see problems and setbacks as challenges and opportunities. They tend to reflect a lot on their goals, the reasons of their success and the lessons they learn when they do not succeed. In other words, they recognize, analyze and utilize or correct their strengths and weaknesses. *Swadhyaya* or self-study is one of the *niyamas* for the practitioner of raja yoga. Paramahansa Niranjanananda recommends the SWAN sadhana in order to practise *swadhyaya*. In the SWAN sadhana one watches and analyzes one's S-strengths, W-weaknesses, A-ambitions/aspirations and N-needs. The changes that are necessary in attitudes and personality are then brought about by practices of awareness, the witness attitude, *sakshi bhava*, developing the opposite quality, *pratipaksha bhava*, and discrimination, *viveka*. Patanjali in his *Yoga Sutras* (1:33) suggests:

In relation to happiness, misery, virtue and vice, by cultivating the attitudes of friendliness, compassion, gladness and indifference respectively, the mind becomes purified and peaceful.

Work situation and creativity

Interest and motivation at work is a prime factor for creativity. The concept of total attention and dedication to the action being performed is stated in the *Bhagavad Gita* (2:50):

Therefore, devote thyself to yoga; yoga is skill in action.

It inspires motivation in one's work. We can mould our personality by adopting a moderate lifestyle and by consciously improving the behaviour and thought patterns we want to perfect.

Creativity decreases when a person is being observed, when expected to perform or produce results and when under an authority.

There is a period of optimal behaviour or mastery, called 'the state of flow', during which a person achieves a high level of output and pleasure in any job with little conscious effort. It is accompanied by a sense of wellbeing and high self-esteem. This state happens at a point when the level of perceived challenge is balanced by a person's perceived ability to carry it out. If the challenge is perceived as bigger than one's capacity, anxiety will be the outcome. If the challenge is perceived as too trivial as compared to one's abilities to deal with it, boredom will be the result. The state of flow happens in a path steered between boredom and anxiety. Creative products often materialize in this flow period.

Yoga nidra and creativity

The practice of yoga nidra is familiar to yoga practitioner the world over. It is not only a practice of relaxation but also a practice of pratyahara and dharana. In the first preparatory stage of yoga nidra, physical and mental relaxation starts, brain waves start slowing down and the senses begin to withdraw from the external environment. It prepares the mind to be receptive. The second stage, taking a resolve, is not directly influencing creativity. The third stage, rotation

of consciousness on body parts, deepens physical as well as mental relaxation and introversion. It discourages the mind from going into slumber. The fourth stage, awareness of breath, further intensifies relaxation and introversion. In this stage dharana begins. Together these stages prepare the ground for the creative potential of the brain to manifest as the normal preponderance of logical left hemisphere activity is replaced by activation of the whole brain. The fifth stage, experiencing opposite feelings and sensations, helps in purging emotions and finding emotional balance. The sixth stage, visualization, allows stored material in the subconscious and unconscious mind to come to the conscious level in the form of images and symbols. It is a stage of extra-sensory perception. The hidden or submerged knowledge can surface at this time. In the fifth and sixth stages there is right brain preponderance which is directly responsible for creativity.

Yoga nidra puts us in touch with our psychic personality that is responsible for all that we think and do. It provides an opportunity to receive and fully assimilate information. In the seventh stage the resolve of the second stage is repeated. The last and eighth stage involves externalization and ending the practice. Thus the whole practice of yoga nidra awakens and enhances one's creative potentials.

Under the guidance of Yoga Research Foundation (YRF), Shri Shirish Kumar Gupta (MSc Applied Yogic Science, Bihar Yoga Bharati, 2003–2005) conducted an experiment to study the effect of yoga nidra on creativity in school children as his project work. YRF presents his findings here.

Effect of Yoga Nidra on Creativity in School Children, 2004

Aim

To study the effect of yoga nidra as compared to sports and games on the creativity in children.

Method

This study was conducted over a period of one month from 10 June to 10 July 2004 on 60 students of class V and VI (age 10–12 years) of a school in Satna, MP, India. The experimental and control groups consisted of 30 students each; 15 students of class V and 15 of class VI. Assignment to either group was done randomly using a lottery method. The experimental group received 25 minutes of yoga nidra every working day for one month and the control group had their normal game and sports class during the same time period. Yoga nidra stages 1 (preparation), 3 (rotation of awareness), 4 (breath awareness), 5 (pairs of opposite sensations), 6 (visualization) and 8 (externalization) were used. Only one parameter consisting of ten sub-tests was studied before and after the duration of the experiment. A panel of three teachers was selected to mark each subject in the TCTC test.

Parameter

Ten Creativity Tests for Children (TCTC): This test is developed by the researcher based on ideas from existing recognized creativity tests. It consists of ten tests measuring ten dimensions of creativity, namely:

1. Object-Idea Test: object-idea association ability
2. Geometry Figure Test: creativity with geometrical shapes
3. Consequence Test: ability to think/imagine about consequences
4. Problem Searching Test: ability to foresee/identify a problem

5. Changing the Drawing Test: ability to think/express alternatives
6. Story Completion Test: sequential imagination
7. Game Invention Test: ability to find fun/recreation in a routine situation
8. Tool Invention Test: ability to solve a mechanical problem
9. Figure-Thought Test: ability to convert abstract thought into an expression/figure
10. Inquisition Test: ability to express curiosity

Results

The findings of TCTC test before and after one month of intervention of yoga nidra are presented in Table 1. In both the groups the post values are higher showing the combined effects of familiarization and the respective intervention, either yoga or sports and games. However, the rise in value is more in the yoga group for all tests. In all the dimensions of creativity children practising yoga nidra have performed better.

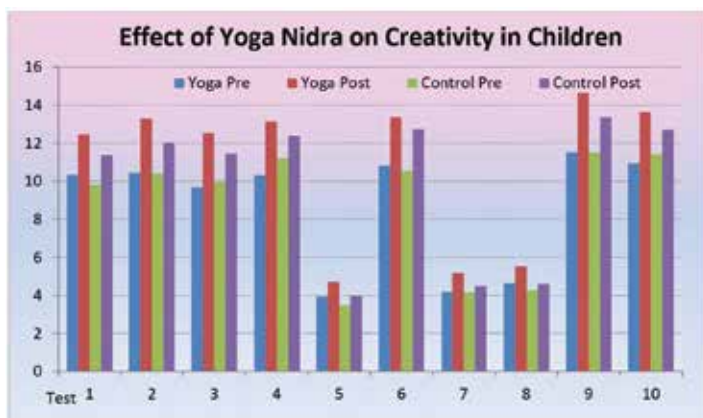
The differences between the yoga and control groups in pre-tests are not significant but are very significant in post-tests. Except tests 1 and 6, the subjects of the yoga nidra group have scored statistically significantly better, their creative potentials have become manifest. See Table 1 and the accompanying graph. This indicates that yoga nidra awakens the creative potential of the whole brain and not only of a selected area of the brain.

Table 1: Effect of yoga nidra on creativity in children

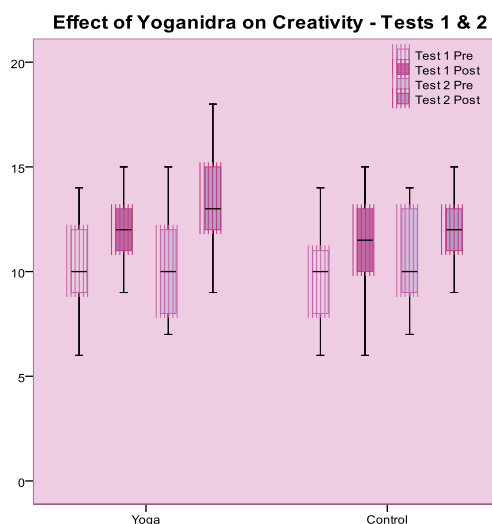
Test No.	n=60	Yoga		Control		F	Significance	Partial eta sq	Observed power	
		Mean	Std dev	Mean	Std dev					
1	Object-Idea	Pre	10.33	1.99	9.80	1.96	1.406	0.241	0.024	0.214
		Post	12.43	1.83	11.37	1.87				
2	Geometry Figure	Pre	10.43	2.46	10.40	2.31	6.003	0.017	0.094	0.673
		Post	13.30	2.29	12.03	1.63				
3	Consequence Test	Pre	9.67	2.60	10.00	3.13	6.410	0.014	0.100	0.702
		Post	12.53	2.27	11.43	1.98				
4	Problem Searching	Pre	10.30	2.31	11.23	2.19	8.621	0.005	0.129	0.823
		Post	13.13	1.81	12.37	1.61				
5	Changing the Drawing	Pre	3.93	0.82	3.50	0.73	3.706	0.059	0.060	0.473
		Post	4.70	0.92	3.95	0.83				
6	Story Completion	Pre	10.80	1.99	10.53	1.78	0.712	0.402	0.012	0.132
		Post	13.37	1.27	12.73	1.11				

Table 1cont.

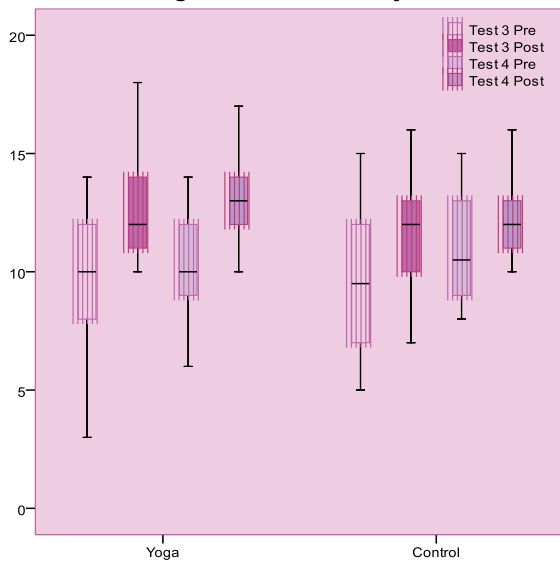
Test No.	n=60	Yoga			Control		F	Significance	Partial eta sq	Observed power
		Mean	Std dev	Mean	Std dev					
7	Game Invention	Pre	4.18	0.80	4.13	0.71	7.937	0.007	0.120	0.791
		Post	5.18	0.65	4.50	0.64				
8	Tool Invention	Pre	4.63	0.77	4.27	1.02	5.540	0.022	0.087	0.639
		Post	5.52	0.78	4.60	0.77				
9	Figure-Thought Test	Pre	11.50	1.72	11.50	1.55	10.661	0.002	0.155	0.894
		Post	14.63	1.52	13.37	1.52				
10	Inquisition Test	Pre	10.93	1.74	11.40	1.79	8.021	0.006	0.121	0.795
		Post	13.63	1.67	12.70	1.32				
Total		Pre	86.72	7.56	86.77	10.11	46.845	0.000	0.905	1.000
		Post	108.43	6.23	99.05	5.60				



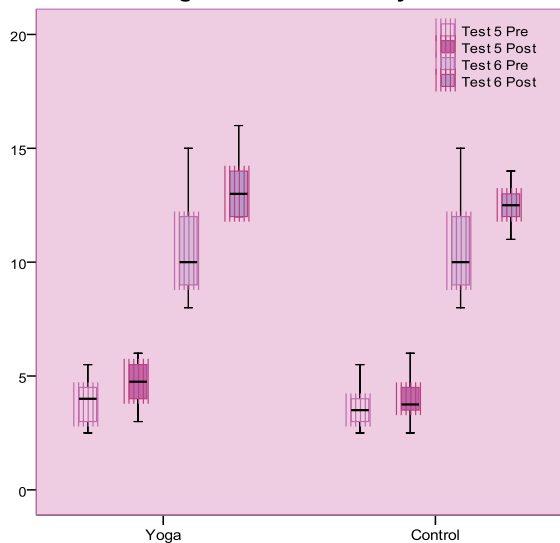
When the data was analyzed using percentile table and box plot graphs it became evident that the improvement in the yoga group was uniform, the high scoring (75 percentile) and the low scoring (25 percentile) of all subjects showed more or less equal improvement. In the control group the improvement was more in the low scoring (25 percentile) group. See the graphs below. The last of the six graphs shows the total score of all the ten subtests.



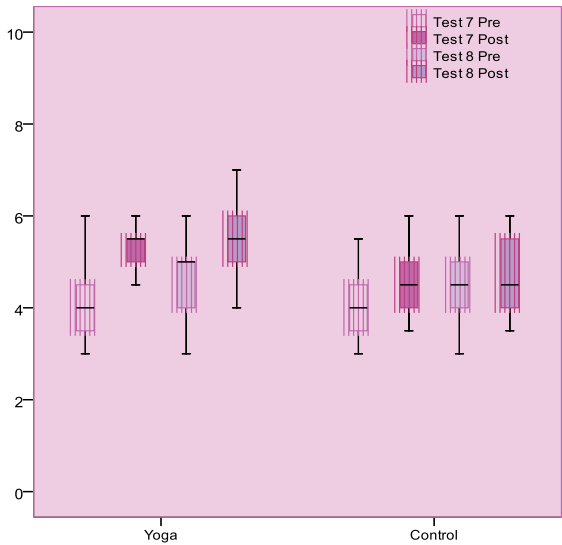
Effect of Yoganidra on Creativity - Tests 3 & 4



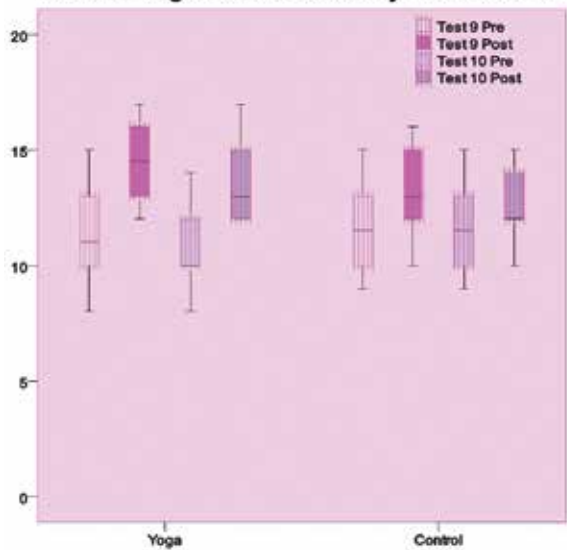
Effect of Yoganidra on Creativity - Tests 5 & 6

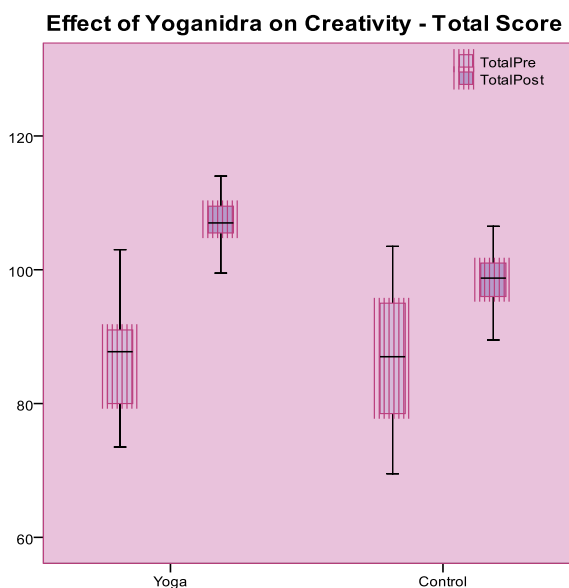


Effect of Yoganidra on Creativity - Tests 7 & 8



Effect of Yoganidra on Creativity - Tests 9 & 10





Conclusion

The practice of yoga nidra is efficient in activating the dormant potential of creative expression in all areas of human expression.

References

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- Swami Satyananda Saraswati, (1998), *Yoga Nidra*, Bihar School of Yoga, Munger, Bihar, India.



Yoga does not go by beliefs; it goes by investigations and discoveries. I want to develop the scientific side of yoga with the help of open-minded examiners and investigators because yoga science has much to contribute to the good of humanity.

I am absolutely sure about it. It is science, scientists, and scientific thinking which will preside over the destiny of humankind, and this science will recognize the potential of yoga for humanity

—Swami Satyananda Saraswati

Volume Three of Yoga Research Foundation presents research studies carried out on various hatha yoga shatkarmas, surya namaskara and on a series of pranayama practices. A study exploring the effect of yoga nidra on creativity and relaxation concludes the volume.

The introductory texts by Swami Sivananda, Sri Swami Satyananda and Swami Niranjanananda place these yoga practices in a wider context relevant to an individual's physical, mental, emotional and spiritual wellbeing and growth.



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